Technical University of Denmark



An environmental assessment system for environmental technologies

Clavreul, Julie; Baumeister, Hubert; Christensen, Thomas Højlund; Damgaard, Anders

Published in: Environmental Modelling & Software

Link to article, DOI: 10.1016/j.envsoft.2014.06.007

Publication date: 2014

Document Version Peer reviewed version

Link back to DTU Orbit

Citation (APA): Clavreul, J., Baumeister, H., Christensen, T. H., & Damgaard, A. (2014). An environmental assessment system for environmental technologies. Environmental Modelling & Software, 60, 18-30. DOI: 10.1016/j.envsoft.2014.06.007

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Supplementary information

EASETECH – an Environmental Assessment System for Environmental TECHnologies

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"NOTE: this is the author's version of a work that was accepted for publication in Environmental Modelling and Software journal. Changes resulting from the publishing process, such as peer review, editing, corrections, structural formatting, and other quality control mechanisms may not be reflected in this document. Minor changes may have been made to this manuscript since it was accepted for publication. A definitive version is published in Environmental Modelling and Software, vol 60, pp 18-30, doi: 10.1016/j.envsoft.2014.06.007"

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PART I: EXAMPLE OF TESTING OF THE CONCEPTUAL MODEL

The testing of the conceptual model was performed using the FitNesse Wiki, an automated testing tool which uses the Framework for Integrated Tests (Fit) to evaluate user stories in the context of the developed conceptual model. Figure S1 presents an example of such a Wiki page testing the correct computation of life cycle inventories (LCI).

This user story is one of the first ones that were implemented. It consists of 3 input tables and of one result table. The objective is to enter input values and check if the conceptual model gives the expected result in the last table. Note that the text outside of tables is only comments and is never evaluated.

In the 1st table, a waste process is defined that uses 2 MJ/kg of electricity per kg of wet weight of the input waste. This electricity is supplied by an external process called "1 MJ Electricity production (DK)". The 2nd table describes the elementary flows induced by the external process "1 MJ Electricity production (DK)": producing 1 MJ of electricity will emit 20 kg CO₂ into the air. The 3rd table describes the waste input: here the waste has a wet weight of 2 kg. Finally the last table computes the LCI of the process. The green color shows that the result is the one we expected: the emission of 80 kg of CO₂ into the air.

This simple example illustrates how basic calculations can be tested in the FitNesse Wiki.

We want to incinerate 2 tons of waste without any remains, and we are using 2 units per ton of the process "1MJ Electricity production (DK)".

WasteProcessFixture							
Amount	ExternalProcess	WasteProperty	edit?				
-2 MJ/kg	1MJ Electricity production (DK)	Wet weight	true				

ExternalProcessFixture						
Name	Flow produced	Amount	create?			
1MJ Electricity production (DK)	"CO2, kg, to air"	20 kg/MJ	true			

WasteFixture						
WasteProperty	Value	create?				
Wet weight	2 kg	true				

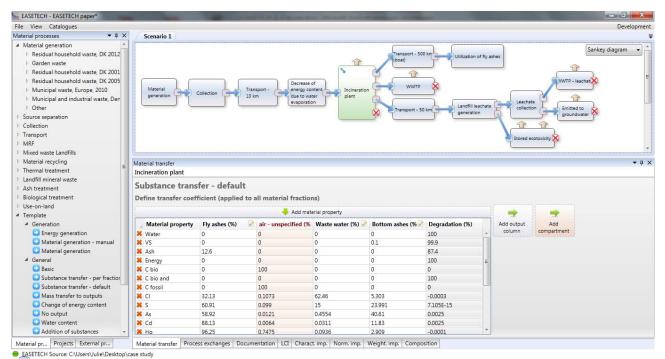
The result is a list of <u>ElementaryFlow</u> produced by the <u>WasteProcess</u>. LciFixture ElementaryFlow Amount "CO2, kg, to air" 80 kg

Figure S1: Example of a FitNesse Wiki page testing the conceptual model

PART II: SCREENSHOTS

All numbers refer to the general overview of the interface in Figure 5 of the article.

"Material transfer" tab (2a):



"Process exchanges" tab (2b):

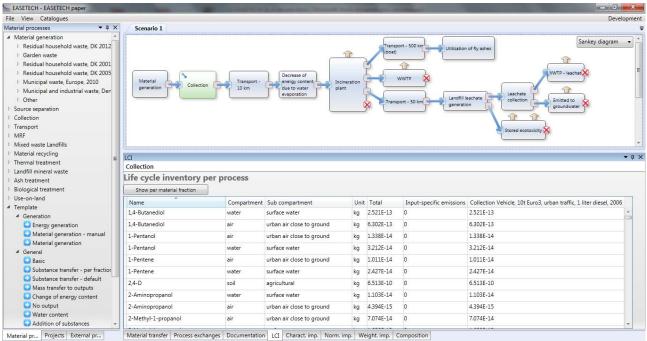
EASETECH - EASETECH paper*		×
File View Catalogues	Devel	opment
Material processes 🔹 🖣 🗙	Scenario 1	Ŧ
Material generation Residual household waste, DK 2012 Garden waste Residual household waste, DK 2001 Residual household waste, DK 2001 Runicipal waste, Europe, 2010 Municipal and industrial waste, Der Other Source separation Collection Transport MRF Mixed waste Landfills	Material generation 10 km	
Mixed waste Landhis Material recycling Thermal treatment	Process exchanges Collection	•
Landfill mineral waste Ash treatment Biological treatment Use-on-land	External processes Add external process Name Amount Unit Per Comment	
Template Generation Generation Material generation - manual Material generation General General Substance transfer - per fraction Substance transfer - default Mass transfer to outputs Change of energy content No output Water content Addition of substances water content	Collection Vehicle, 10t Euro3, urban traffic, 1 liter diesel, 2006 0.00327*ghg_diesel kg Total Wet Weight Elementary exchanges Add elementary exchange	

"Documentation" tab (2c):

EASETECH - EASETECH paper	The second second	THE LOCAL DIVISION NAMES		×
File View Catalogues			Dev	elopme
Vaterial processes 🔹 🖣 🗙	Scenario 1			
Material generation A datarial generation Barden waste Barden waste Barden waste Bresidual household waste, DK 2001 Bresidual household waste, DK 2005 Municipal waste, Europe, 2010 Municipal waste, Europe, 2010 Municipal waste, Europe, 2010 Source separation Collection Transport MRF Mixed waste Landfills	Material generation	Collection Transport	Decresse of WVTP - leachat	
Material recycling				
1 Thermal treatment	ocumentation Collection			Ψų
P Ash treatment	lame:	Collection	DQI:	
Biological treatment	vonie.	ario 1 ario 1 ario 1 ario 1 ario 1 aris 200 m aris 200 m	4	
	Date Created:	15 June 2013	Data Undatadi, 14 Neuranhos 2012	
▲ Template				
	Scenario 1 Currentation Curr			
Energy generation		Life Cleveral		5
	vata entered by:	Julie Clavreul	Technological Correlation:	4
Material generation General	Seneral Technolog	gy Description:		
Basic Substance transfer - per fraction Substance transfer - default Mass transfer to outputs Change of energy content No output Water content	PROCESS Collection is defin start of the collec for transportation Curbside collectio	ned in terms of fuel consumption p ction route, driving from the final st n is found in a corresponding datas on of residual household waste is p	mily houses in an urban residential area by a collection truck. er tonne of wet waste from the first stop on the collection route to the final stop on the collection route [1]. Fuel spent on driving from the garage op on the collection route to the unloading point, and driving from that point back to the garage is considered part of transportation. Fuel consu et under transportation technologies. erformed in collection trucks (weight of truck app. 7-13 tonnes) and follows a regular scheme. The average load of a full truck is 4-10 tonnes of w -family houses are placed in an urban area. Every house has its own bin (app. 190 liters) which is emptied fortnightly.	mption

EASETECH Source: C:\Users\Julie\Desktop\case study

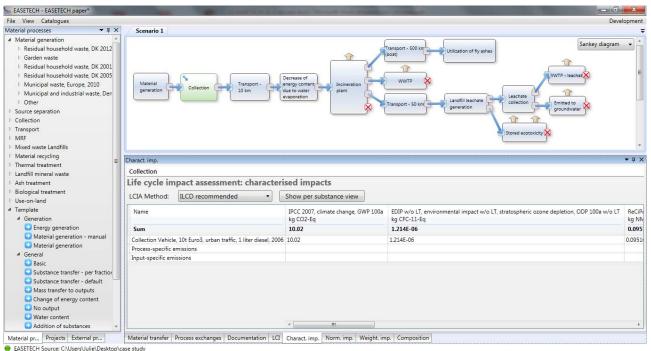
"LCI" tab (2d):



"Characterised impacts" tab, "per substance" and "per process" views (2e):

File View Catalogues					Developm
Vaterial processes 🔹 🔻 🗸 🗙	Scenario 1				
Material generation In Residual household waste, DK 2012 Garden waste D Residual household waste, DK 2001 D Residual household waste, DK 2005 Municipal and industrial waste, Der D Other Source separation Collection Transport MRF Material recycling	Material generation Collection	Transport - 10 km	Decrease of energy content due to water evaporation		ntion of fly ashes
 Landfill mineral waste Ash treatment 	Collection Life cycle impact asse				
Landfill mineral waste			terised impacts Show per process view		
Landfill mineral waste Ash treatment Biological treatment Use-on-land	Life cycle impact asse			IPCC 2007, climate change, GWP 100a kg CO2-Eq	EDIP w/o LT, environmental impact w/o LT, stratospheric ozone dep kg CFC-11-Eq
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template	Life cycle impact asse LCIA Method: ILCD recon	nmended 🗸 🗸	Show per process view		
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template	Life cycle impact asse LCIA Method: ILCD recon	nmended 🗸 🗸	Show per process view Sub compartment	kg CO2-Eq	kg CFC-11-Eq
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Energy generation Material generation - manual Material generation	Life cycle impact asse LCIA Method: ILCD recon Name Sum	Compartment	Show per process view Sub compartment	kg CO2-Eq 10.02 9.238	kg CFC-11-Eq 1.214E-06
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil	nmended • •	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks	kg CO2-Eq 10.02 9.238 0.5634	kg CFC-11-Eq 1.214E-06 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General General Saic	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil Carbon dioxide, fossil	nmended •	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks	kg CO2-Eq 10.02 9.238 0.5634	kg CFC-11-Eq 1.214E-06 0 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template 4 Generation Material generation Material generation Material generation 4 General 2 Basic 2 Substance transfer - per fractior	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil	nmended - Compartment air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified	kg CO2-Eq 10.02 9.238 0.5634 0.124	kg CFC-11-Eq 1.214E-06 0 0 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General Basic Substance transfer - per fractior Substance transfer - default	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon dioxide, fossil	onmended	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground	kg CO2-Eq 10.02 9.238 0.5634 0.124 0.06358	kg CFC-11-Eq 1.214E-06 0 0 0 0 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General General General General General Substance transfer - per fraction Substance transfer - default Mass transfer to outputs	Life cycle impact asse LCIA Method: ILCD recon Name Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil	air air air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified urban air close to ground	kg CO2-Eq 10.02 9.238 0.5534 0.124 0.05558 0.01791 0.004834	kg CFC-11-Eq 1.214E-06 0 0 0 0 0 0 0 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation Material generation Material generation Material generation Material generation Substance transfer - per fractior Substance transfer - oferault Mass transfer - oderault Mass transfer - oderault Mass transfer - oderault	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon monoxide, fossil Methane, fossil Methane, fossil	Compartment air air air air air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground urban air close to ground non-urban air or from high stacks	kg CO2-Eq 10.02 9.238 0.5534 0.124 0.05558 0.01791 0.004834	kg CFC-11-Eq 1.214E-06 0 0 0 0 0 0 0 0 0
Ash treatment Biological treatment Use-on-land Cemplate Generation Material generation Material generation General Basic Substance transfer - per fractior Substance transfer - default Material stransfer to outputs	Life cycle impact asse LCIA Method: ILCD recon Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil Carbon monoxide, fossil Methane, fossil Dinitrogen monoxide	Anmended Compartment air air air air air air air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground urban air close to ground non-urban air or from high stacks	kg CO2-Eq 10.02 9.238 0.6544 0.06358 0.01791 0.004834 0.003523 0.002598	kg CFC-11-Eq 1.214E-06 0 0 0 0 0 0 0 0 0 0 0 0

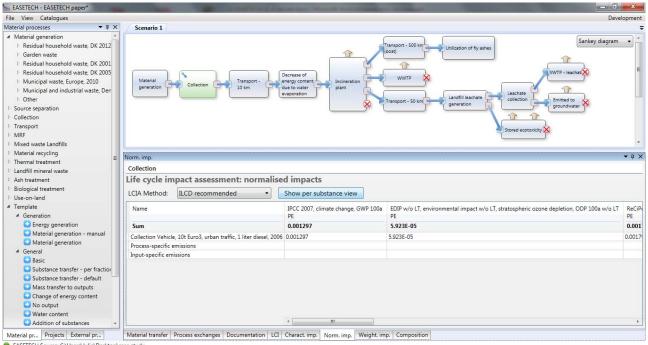
Material pr., Projects External pr., Material transfer Process exchanges Documentation LCI Charact. imp. Norm. imp. Weight. imp. Composition



"Normalised impacts" tab, "per substance" and "per process" views (2f):

File View Catalogues					Developmen
Material processes 🔹 🔻 🗸 🗙	Scenario 1				
Material generation Peridual household waste, DK 2012 Garden waste Residual household waste, DK 2001 Residual household waste, DK 2005 Municipal waste, Europe, 2010 Municipal and industrial waste, DC 2005 Municipal and industrial waste, DC 2005 Source separation Collection Transport MRF	Generation Collection	Transport - 10 km	Decrease of energy content due to water evaporation		tion of fly ables fill leachate ration Stored ecotoxioty Stored ecotoxioty
Mixed waste Landfills	L				
Material recycling Thermal treatment	Norm. imp.				↓ ‡
Landfill mineral waste	Collection				
Ash treatment	Life cycle impact asses	ssment: norma	lised impacts		
Biological treatment			· · · · · · · · · · · · · · · · · · ·		
 Biological treatment Use-on-land 	LCIA Method: ILCD recom		Show per process view		
 Use-on-land Template 			Show per process view Sub compartment	IPCC 2007, climate change, GWP 100a	EDIP w/o LT, environmental impact w/o LT, stratospheric ozone deplo
Use-on-land	LCIA Method: ILCD recom	mended 🔹) ()	PE	PE
Use-on-land Template Generation	LCIA Method: ILCD recom	mended •	Sub compartment	PE 0.001297	PE 5.923E-05
Use-on-land Template Generation Energy generation	LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil	mended •	Sub compartment urban air close to ground	PE 0.001297 0.001195	PE 5.923E-05 0 4
Use-on-land Template Generation Energy generation Material generation - manual	LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil	Compartment	Sub compartment urban air close to ground non-urban air or from high stacks	PE 0.001297 0.001195 7.288E-05	PE 5.923E-05 0 0 0
Use-on-land Template Generation Material generation - manual Material generation	LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil	mended Compartment	Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks	PE 0.001297 0.001195 7.288E-05 1.604E-05	PE 5,923E-05 0 0
Use-on-land Template Generation Energy generation Material generation Material generation Content of the template set of template set o	LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon dioxide, fossil	mended • Compartment air air air air	Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified	PE 0.001297 0.001195 7.288E-05 8.225E-06	PE 5.923E-05 0 0 0 0 0
Use-on-land Template Generation Rergy generation Material generation Material generation General Basic	LCIA Method: ILCD recom Name Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil	mended Compartment air air air air air air air	Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified urban air close to ground	PE 0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.317E-06	PE 5.923E-05 0 0 0 0 0 0
Use-on-land Template Generation Material generation Material generation General Basic Substance transfer - per fraction	LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon monoxide, fossil Methane, fossil Methane, fossil	mended • Compartment air air air air air air air	Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified urban air close to ground urban air close to ground	PE 0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.317E-06 6.254E-07	PE 5,923E-05 0 0 0 0 0 0
Use-on-land Template Generation Material generation - manual Material generation General Sasic Substance transfer - per fraction Substance transfer - default	LCIA Method: [LCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon monoxide, fossil Carbon monoxide, fossil Methane, fossil Dinitrogen monoxide	mended • Compartment air	Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground non-urban air or from high stacks	PE 0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.317E-06 6.254E-07 4.557E-07	PE 5,923E-05 0 0 0 0 0 0 0 0 0 0
Use-on-land Template Generation Generation Generation Generation Generation Generation Generat Genera	LCIA Method: ILCD recom Name Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil Methane, fossil Dinitrogen monoxide Dinitrogen monoxide	mended • Compartment air air air air air air air air air	Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified urban air close to ground urban air close to ground non-urban air or from high stacks urban air close to ground	PE 0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 6.234E-07 4.557E-07 3.36E-07	PE 5923E-05 0 0 0 0 0 0 0 0 0 0 0 0
Use-on-land Template Generation Material generation - manual Material generation General Basic Substance transfer - per fractior Substance transfer - default Mass transfer to outputs Change of energy content	LCIA Method: [LCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil Carbon monoxide, fossil Carbon monoxide, fossil Methane, fossil Dinitrogen monoxide	mended • Compartment air	Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground non-urban air or from high stacks	PE 0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 6.234E-07 4.557E-07 3.36E-07	PE 5,923E-05 0 0 0 0 0 0 0 0 0 0

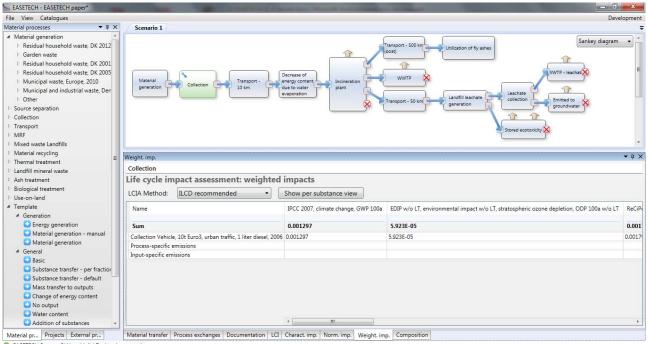
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"Weighted impacts" tab, "per substance" and "per process" views (2g):

File View Catalogues					Developmen
Material processes 🔹 🖣 🗙	Scenario 1				
Material generation Residual household waste, DK 2012 Garden waste Residual household waste, DK 2001 Residual household waste, DK 2001 Runicipal waste, Europe, 2010 Municipal and industrial waste, Der Other Source separation Collection Transport MRF Mixed waste landfills.	Material generation Collection	Transport - 10 km	Decresse of energy content due to waporation		tion of fly ashes Sankey diagram
Mixed waste Landfills Material recycling					1
	Weight, imp.				▼ ‡
1 Thermal treatment					
Thermal treatment Jandfill mineral waste	Collection				
Thermal treatment Landfill mineral waste Ash treatment		ssment: weigh	ted impacts		
 Landfill mineral waste Ash treatment 	Life cycle impact asses	5			
Landfill mineral waste Ash treatment Biological treatment		5	ted impacts Show per process view		
 Landfill mineral waste Ash treatment 	Life cycle impact asses	5	Show per process view	IPCC 2007, climate change, GWP 100a	EDIP w/o LT, environmental impact w/o LT, stratospheric ozone deple
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Dergy generation	Life cycle impact asses	mended •	Show per process view	IPCC 2007, climate change, GWP 100a 0.001297	EDIP w/o LT, environmental impact w/o LT, stratospheric ozone deple 5.923E-05
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Energy generation Material generation - manual	Life cycle impact asses LCIA Method: ILCD recom	mended •	Show per process view		
Landfill mineral waste Ash treatment Use-on-land Template Generation Material generation Material generation Material generation	Life cycle impact asset LCIA Method: ILCD recom Name Sum	mended •	Show per process view Sub compartment urban air close to ground	0.001297 0.001195	5.923E-05
Landfill mineral waste Ash treatment Use-on-land Generation Material generation Generation Generation	Life cycle impact asses LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil	mended • Compartment air	Sub compartment	0.001297 0.001195 7.288E-05	5.923E-05 0
Landfill mineral waste Ach treatment Biological treatment Use-on-land Template Generation Material generation Material generation General Basic	Life cycle impact asset LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil	mended • Compartment air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks	0.001297 0.001195 7.288E-05	5,923E-05 0 0
Landfill mineral waste Ash treatment Sicological treatment Use-on-land Generation Generation Material generation Material generation General Basic Substance transfer - per fractior	Life cycle impact asset LCIA Method: LLCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil	mended Compartment air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks	0.001297 0.001195 7.288E-05 1.604E-05	5,923E-05 0 0
Landfill mineral waste Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General Basic Substance transfer - per fractior Substance transfer - default	Life cycle impact asses LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil	mended • Compartment air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified	0.001297 0.001195 7.288E-05 8.225E-06	5.923E-05 0 0 0 0 0
Landfill mineral waste Ach treatment Biological treatment Use-on-land Template Generation Material generation Material generation General Substance transfer - per fractior Substance transfer - default Mass transfer to outputs	Life cycle impact asset LCIA Method: LICD recom Name Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil	mended Compartment air air air air air air air air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks non-urban air or from high stacks unspecified urban air close to ground	0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.317E-06 6.254E-07	5,923E-05 0 0 0 0 0 0 0 0
Landfill mineral waste Ash treatment Use-on-land Emplat Generation Material generation Material generation Material generation Substance transfer - per fractior Substance transfer - default Mass transfer to outputs Change of energy content	Life cycle impact asset LCIA Method: LLCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Methane, fossil	mended Compartment air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground	0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.317E-06 6.254E-07	5,923E-05 0 0 0 0 0 0 0
Landfill mineral waste Ach treatment Biological treatment Use-on-land Template Generation Material generation Material generation General Substance transfer - per fractior Substance transfer - default Mass transfer to outputs	Life cycle impact asset LCIA Method: ILCD recom Name Sum Carbon dioxide, fossil Carbon dioxide, fossil Carbon dioxide, fossil Carbon monoxide, fossil Carbon monoxide, fossil Dinitrogen monoxide	mended Compartment air	Show per process view Sub compartment urban air close to ground non-urban air or from high stacks unspecified urban air close to ground urban air close to ground non-urban air or from high stacks	0.001297 0.001195 7.288E-05 1.604E-05 8.225E-06 2.2317E-06 6.234E-07 4.557E-07 3.36E-07	5,923E-05 0 0 0 0 0 0 0 0 0

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"Composition" tab (2h):

												Deve	lopme
laterial processes 🔹 🕈 🗙 S	cenario 1												
Municipal and industrial waste, Den Other Source separation Collection Transport MRF	Material Collection	Transport - ener 10 km due	rease of rgy content to water soration	Incinera	tion	Transport - S		Utilization of fly Landfill leachat generation	te Cleachar collecti		TP - leachat	nkey diagram	•
	position ection - Adv. Waste Generation												▲ ù
Ash treatment Disp	blay Default	•											
Ash treatment Disp Biological treatment		Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (ka)	Energy (MI)	C bio (ka)	C bio and (kg)	C fossil (ka)	Ca (kg)	CI (ka)	F
Ash treatment Disp Biological treatment Use-on-land Fra	olay Default action name	Total Wet Weight (kg) 1000	TS (kg) 329.049	Water (kg)	VS (kg) 300	Ash (kg) 29.06	Energy (MJ) 6438	C bio (kg)	C bio and (kg) 104.4	C fossil (kg) 9.466	Ca (kg)	CI (kg)	
Ash treatment Disp Biological treatment Use-on-land Fro Template Su	action name J m			all second and		-		and the second second	-		Constanting of the second	-	F C 0.6
Ash treatment Disp Biological treatment Use-on-land Fro Template Su	action name Jm getable food waste	1000 623.9	329.049 143.52	671 480.4	300 136.1	29.06 7.463	6438 2626.416	154.2 68.172	104.4 60.71	9.466 0.343	5.682 0.7965	2.888 0.8037	C 0.1
Ash treatment Biological treatment Usecon-land Template Generation Material generation - manual Material generation - manual	action name m getable food waste imal food waste	1000 623.9 196.1	329.049 143.52 84.084	671 480.4 112	300 136.1 76.77	29.06 7.463 7.315	6438 2626.416 2064	154.2 68.172 46.58	104.4 60.71 30.27	9.466 0.343 0.9501	5.682 0.7965 3.439	2.888 0.8037 1.371	0.0
Ash treatment Disp Biological treatment Use-on-land Tremplate Su Ceneration Energy generation Veg Material generation Anni Material generation Kitte	action name m getable food waste imal food waste chen towels	1000 623.9 196.1 64.974	329.049 143.52 84.084 34.515	671 480.4 112 30.459	300 136.1 76.77 33.58	29.06 7.463 7.315 0.9319	6438 2626.416 2064 585.7	154.2 68.172 46.58 15.43	104.4 60.71 30.27 8.698	9.466 0.343 0.9501 0.156	5.682 0.7965 3.439 0.1356	2.888 0.8037 1.371 0.08974	0.1 0.1 0.1
Ash treatment Disp Biological treatment Use-on-land France Template Su Deservation Supervation - manual Material generation - Manual - Manua	action name m getable food waste imal food waste chen towels ty paper	1000 623.9 196.1 64.974 3.999	329.049 143.52 84.084 34.515 3.02	671 480.4 112 30.459 0.9788	300 136.1 76.77 33.58 2.751	29.06 7.463 7.315 0.9319 0.2688	6438 2626.416 2064 585.7 54.87	154.2 68.172 46.58 15.43 1.347	104.4 60.71 30.27 8.698 0.453	9.466 0.343 0.9501 0.156 0.02748	5.682 0.7965 3.439 0.1356 0.03292	2.888 0.8037 1.371 0.08974 0.0145	0.1 0.1 0.1 0.1 0.1
Ash treatment Disp Biological treatment Use-on-land Template Su	action name m getable food waste imal food waste chen towels ty paper ty cardboard	1000 623.9 196.1 64.974 3.999 3	329.049 143.52 84.084 34.515 3.02 2.607	671 480.4 112 30.459 0.9788 0.393	300 136.1 76.77 33.58 2.751 2.219	29.06 7.463 7.315 0.9319 0.2688 0.3884	6438 2626.416 2064 585.7 54.87 44.24	154.2 68.172 46.58 15.43 1.347 1.113	104.4 60.71 30.27 8.698 0.453 0.3702	9.466 0.343 0.9501 0.156 0.02748 0.01124	5.682 0.7965 3.439 0.1356 0.03292 0.0902	2.888 0.8037 1.371 0.08974 0.0145 0.003389	0.1 0.1 0.1 0.1 0.1
Ash treatment Biological treatment Use-on-land Template Generation Material generation - manual Material generation General Basic Substance transfer - per fraction Substance transfer - default No	action name m getable food waste imal food waste chen towels ty paper	1000 623.9 196.1 64.974 3.999	329.049 143.52 84.084 34.515 3.02	671 480.4 112 30.459 0.9788	300 136.1 76.77 33.58 2.751	29.06 7.463 7.315 0.9319 0.2688	6438 2626.416 2064 585.7 54.87	154.2 68.172 46.58 15.43 1.347	104.4 60.71 30.27 8.698 0.453	9.466 0.343 0.9501 0.156 0.02748	5.682 0.7965 3.439 0.1356 0.03292	2.888 0.8037 1.371 0.08974 0.0145	0.1 0.1 0.1 0.1 0.1
Ash treatment Biological treatment Use-on-land Template Generation Dergy generation Dergy generation Material generation General Substance transfer - per fraction Substance transfer - default Substance transfer - default Substance transfer - default Substance transfer - default Mass transfer to outputs	action name im getable food waste imal food waste chen towels ty paper ty cardboard in-recyclable plastic	1000 623.9 196.1 64.974 3.999 3	329.049 143.52 84.084 34.515 3.02 2.607	671 480.4 112 30.459 0.9788 0.393	300 136.1 76.77 33.58 2.751 2.219	29.06 7.463 7.315 0.9319 0.2688 0.3884	6438 2626.416 2064 585.7 54.87 44.24	154.2 68.172 46.58 15.43 1.347 1.113	104.4 60.71 30.27 8.698 0.453 0.3702	9.466 0.343 0.9501 0.156 0.02748 0.01124	5.682 0.7965 3.439 0.1356 0.03292 0.0902	2.888 0.8037 1.371 0.08974 0.0145 0.003389	0.1 1.0 1.0 1.0 1.0 1.0
Ash treatment Biological treatment Use-on-land Template Desenation Desenation Material generation Material generation Material generation Substance transfer - per fraction Substance transfer - default Mass transfer to outputs Mass transfer to outputs Mass transfer to outputs Mass transfer to outputs Mass transfer to outputs Constance transfer to outputs Mass transfer to outputs	action name im getable food waste imal food waste chen towels ty paper ty cardboard in-recyclable plastic	1000 623.9 196.1 64.974 3.999 3 11 71.01	329.049 143.52 84.084 34.515 3.02 2.607 10.219	671 480.4 112 30.459 0.9788 0.393 0.7843	300 136.1 76.77 33.58 2.751 2.219 9.657	29.06 7.463 7.315 0.9319 0.2688 0.3884 0.562	6438 2626.416 2064 585.7 54.87 44.24 326.6	154.2 68.172 46.58 15.43 1.347 1.113 0.03628	104.4 60.71 30.27 8.698 0.453 0.3702 0	9.466 0.343 0.9501 0.156 0.02748 0.01124 7.215	5.682 0.7965 3.439 0.1356 0.03292 0.0902 0.1114	2.888 0.8037 1.371 0.08974 0.0145 0.003389 0.4782	0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1
Ash treatment Biological treatment Uses-on-land Template Generation Material generation Material generation Material generation Material generation Construct transfer - per fraction Substance transfer - per fraction Change of energy content No Material generation Construct transfer - default No Material generation Material generation Materia	action name m getable food waste imal food waste chen towels ty paper ty cardboard n-recyclable plastic rd waste, flowers imal excrements and bedding (straw)	1000 623.9 196.1 64.974 3.999 3 11 71.01	329.049 143.52 84.084 34.515 3.02 2.607 10.219 36.778 6.336	671 480.4 112 30.459 0.9788 0.393 0.7843 34.23	300 136.1 76.77 33.58 2.751 2.219 9.657 27.95	29.06 7.463 7.315 0.9319 0.2688 0.3884 0.562 8.827	6438 2626.416 2064 585.7 54.87 44.24 326.6 494.7	154.2 68.172 46.58 15.43 1.347 1.113 0.03628 15.48	104.4 60.71 30.27 8.698 0.453 0.3702 0 2.685	9.466 0.343 0.9501 0.156 0.02748 0.01124 7.215 0.3163	5.682 0.7965 3.439 0.1356 0.03292 0.0902 0.1114 0.776	2.888 0.8037 1.371 0.08974 0.0145 0.003389 0.4782 0.103	C 0.1 0.1

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"Material fractions" catalogue (4a):

	Material fractions														
	Fraction name	14/ /0/1	TC (9()	NC (9(TC)	A-1- (9/ TC)	Energy (MJ/kgTS)	C his (9/TC)	Chinard (9(TC)	C (C- (9(TC)	CL (PK TC)	F (9/ TC)	11/8/701	K (R/TC)	N1 /0/ 7
							47.5					0.01			
	Vegetable food waste Animal food waste	76.99 57.14			5.2 8.7	18.3	47.5 55.4	42.3	0.239		0.56		6.6 7.9	0.533	1.9 7
3		12.95		91.3		24.55 17.07	55.4 44.6	36 7.3	0.224		1.63	0.01			0.1
	Newsprints										0.03		5.7		
	n Shin Shin ha ka ka ka sa														0.1
															0.3
															0.12
				1000											0.1
															0.2
															0.2
															0.1
															0.4
															0.2
															0.8
															0.3
						1.7.7.7.7.				and shall a second second					0.3
	Soft plastic	14.11	85.9	95.6	4.4	40.06		0		0.11	0.07	0.01			0.2
	Plastic bottles	10.46		93.9	6.1	36.54	0.386	0	76.8		0.17	0.01			0.1
lastic	Hard plastic	3.25	96.8	97.8	2.2	37.41	0.4	0	79.5	0.416	0.1	0.01	10.5	0.019	5.5
lastic	Non-recyclable plastic	7.13	92.9	94.5	5.5	31.96	0.355	0	70.6	1.09	4.68	0.01	9.7	0.121	0.5
Organics	Yard waste, flowers	48.21	51.8	76	24	13.45	42.1	7.3	0.86	2.11	0.28	0.01	5.2	1.27	1.5
Organics	Animal excrements and bedding (straw)	60.42	39.6	74.6	25.4	16.05	43.5	13.2	0.439	2.71	0.13	0.01	6.4	0.739	3.3
Other	Diapers, sanitary towels, tampons	45.52	54.5	91.7	8.3	22.22	49.8	3.9	5.53	0.962	0.14	0.01	8	0.141	0.9
Other	Cotton bandages	55.44	44.6	97.6	2.4	22.19	40.6	4.4	10.1	0.209	0.17	0.01	7.4	0.117	0.4
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	iber iber iber iber composite composite omposite other lastic lastic lastic lastic organics prganics Dther	iber Advertisements iber Office paper Office paper Other clean paper Other clean paper Other clean paper Other clean cardboard omposite Milk cartons (carton/plastic) omposite Juice cartons (carton/plastic/aluminium) ther Kitchen towels Dirty paper Dirty cardboard Iastic Soft plastic Iastic Plastic bottles Iastic Hard plastic Iastic Hard plastic Iastic Non-recyclable plastic Vard waste, flowers Yrganics Animal excrements and bedding (straw) Xther Diapers, sanitary towels, tampons Ither Contron handanes	iber Advertisements 8.75 iber Books, phone books 4.5 iber Office paper 8.75 iber Office paper 8.75 iber Office paper 8.75 iber Other clean paper 7.37 iber Other clean paper 7.37 iber Other clean cardboard 16.52 omposite Mik cartons (carton/plastic/aluminium) 16.14 ther Kitchen towels 46.86 bier Dirty paper 24.47 iber Dirty paper 24.47 lastic Soft plastic 13.1 lastic Dastic bottles 10.46 lastic Hastic bottles 10.46 lastic Hastic bottles 3.25 lastic Non-recyclable plastic 7.13 trganics Animal excrements and bedding (straw) 60.42 Wher Diapers, sanitary towels, tampons 45.52 Wher Corton handanes 55.42	iber Advertisements 8,75 91,3 iber Books, phone books 4,5 95,5 Office paper 8,75 91,3 iber Other clean paper 7,37 92,6 Other clean paper 7,37 92,6 iber Other clean paper 7,37 92,6 iber Paper and carton containers 22,26 77,7 iber Other clean cardboard 1652 83,3 omposite Milk cartons (carton/plastic/aluminium) 16,14 83,9 omposite Juice cartons (carton/plastic/aluminium) 16,14 83,9 biber Dirty paper 24,47 75,5 iber Dirty cardboard 13,1 86,9 lastic Soft plastic 13,1 85,9 lastic Plastic bottles 10,46 89,5 lastic Non-recyclable plastic 3,25 9,68 lastic Non-recyclable plastic 7,13 9,29 roganics Animal excrements and bedding (straw) <t< td=""><td>iber Advertisements 8,75 91,3 72.6 iber Books, phone books 4,5 95.5 82.2 iber Office paper 8,75 91.3 79.3 iber Other clean paper 7,37 92.6 82.61 iber Other clean paper 7,37 92.6 82.61 iber Other clean araboard 16.52 83.5 86 omposite Milk cartons (carton/plastic/aluminium) 16.14 83.9 90.4 omposite Juice cartons (carton/plastic/aluminium) 16.14 83.9 90.4 types 24.47 75.5 91.1 11 85.9 95.6 lastic Dirty cardboard 13.1 86.9 85.1 13.9 14.8 14.11 85.9 93.9 lastic Plastic bottles 10.46 89.5 93.9 14.5 14.11 85.9 94.5 lastic Non-recyclable plastic 7.13 92.9 94.5 17.7 14.8 14.8</td><td>iber Advertisements 8,75 91,3 72,6 27,4 iber Books, phone books 4,5 95,5 82,2 17,8 iber Office paper 8,75 91,3 72,6 27,4 iber Office paper 8,75 91,3 72,6 27,7 iber Other clean paper 7,37 92,6 82,61 17,39 iber Other clean carbon containers 22,26 77,7 86,6 13,4 iber Other clean carbonard 16,52 83,5 86,6 14 omposite Milk cartons (carton/plastic/aluminium) 16,14 83,9 90,4 9,6 typer 2,447 75,5 91,1 8,9 9 9,4 9,6 typer 2,447 75,5 91,1 8,9 9,6 14,9 9 14,9 9 14,9 14,1 8,9 9,6 1,4 14,9 14,1 8,9 9,6 1,1 14,9 14,1 14,9</td><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 Bocks, phone books 4.5 95.5 82.2 17.8 15.06 Ber Office paper 8.75 91.3 79.3 20.7 12.33 Biber Office paper 8.75 91.3 79.3 20.7 12.33 Biber Office paper 8.75 91.3 79.3 20.7 12.53 Biber Office clean paper 7.37 92.6 82.61 17.39 13.15 Other clean cardboard 165.2 83.5 86 14 15.08 omposite Mik cartons (carton/plastic/aluminium) 16.14 83.9 90.4 9.6 23.76 Uther Kitchen towels 46.86 53.1 97.3 2.7 16.97 Iber Dirty paper 24.47 75.5 91.1 8.9 16.17 Iber Dirty cardboard 13.1 86.9 85.1 14.9 16.97 Iastic<!--</td--><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 iber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 iber Office paper 8.75 91.3 72.6 27.4 13.05 34.4 iber Office paper 8.75 91.3 79.3 20.7 12.53 37.3 iber Other clean paper 7.37 92.6 82.61 17.39 13.15 38.1 iber Other clean cardboard 165.2 83.5 86 1.4 15.08 40.7 omposite Mik cartons (carton/plastic/aluminium) 16.14 83.9 90.4 9.6 23.76 50.6 ther Kitchen towels 46.86 53.1 97.3 2.7 16.97 44.7 iber Dirty paper 24.47 75.5 91.1 8.9 16.9 44.7 iber Dirty cardboard 13.1 86.9 85.1 14.9</td><td>advertisements 8,75 91.3 72.6 27.4 13.05 34.4 12.5 biber Ohrice paper 8,75 91.3 72.6 27.4 13.05 34.4 12.5 biber Ohrice paper 8,75 91.3 72.6 27.4 13.05 34.4 12.5 biber Ohrice paper 8,75 91.3 72.6 82.21 17.8 15.06 40.4 21.4 biber Other clean paper 8,75 91.3 72.6 82.61 17.39 13.15 38.1 21.9 biber Other clean cardo containers 22.26 77.7 86.6 13.4 14.97 40.9 15.1 biber Other clean cardboard 16.52 83.5 86 14 15.08 40.7 15.2 omposite Mik cartons (cardon/plastic/aluminium) 16.14 83.9 90.4 9.6 23.76 50.6 8.7 biber Dity paper 24.47 75.5 91.1 8.9 18.17 44.6 15 biber Dity cardboard 13.1 86.9 85.1 14.9 16.97 42.7 14.2 lastic Pastic bottes 10.46 85.9 <t< td=""><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 biber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 biber Office paper 8.75 91.3 73.2 02.6 0.188 biber Office paper 8.75 91.3 73.3 20.7 12.53 37.3 20.6 0.188 biber Other clean paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 biber Other clean cardon containers 22.26 77.7 86.6 13.4 14.97 40.9 15.1 0.206 omposite Milk cartons (carton/plastic/aluminium) 16.14 83.9 90.4 96.6 23.76 50.6 8.7 1.03 ther Kitchen towels 46.86 93.1 97.3 2.7 16.97 44.7 25.2 0.452 ther Nity car</td><td>abserved 8,75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 3.6 biber Advertisements 80.6k, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 4.06 biber Office paper 87.5 91.3 72.6 82.61 17.38 13.73 20.6 0.188 7.77 biber Office paper 87.5 91.3 73.3 20.6 0.188 7.77 biber Other clean paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 4.39 biber Other clean cardon containers 22.26 77.7 86.6 13.4 14.97 40.9 15.1 0.206 2.82 omposite Milk cartons (carton/plastic) 16.82 83.5 86 14 15.08 40.7 15.2 0.205 3.09 omposite Milk cartons (carton/plastic/aluminium) 16.14 83.9 90.4 96.6 23.76 50.6 8.7 1.03 0.727</td><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 3.6 0.03 iber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 40.6 0.03 iber Office paper 8.75 91.3 79.3 20.7 12.53 37.3 20.6 0.188 7.77 0.07 iber Office paper 8.75 91.3 79.3 20.7 12.53 37.3 20.6 0.188 7.77 0.07 iber Office paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 4.39 0.06 iber Office paper Advection containers 22.26 7.77 86.6 13.4 14.97 40.9 15.1 0.205 3.09 0.02 omposite Mik cartons (carton/plastic/) 16.84 83.9 90.4 9.6 23.76 50.6 8.7 1.03 0.78.2 0.11 omposite Mik cartons (carton/plastic/aluminium)<td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 3.6 0.03 0.07 biber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 4.06 0.03 0.016 biber Office paper 8.75 91.3 79.3 20.7 12.53 37.3 20.6 0.188 7.77 0.07 0.01 biber Office paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 4.39 0.06 0.01 biber Office paper and containers 2.26 7.77 86.6 13.4 14.97 40.9 15.1 0.206 2.62 0.03 0.04 omposite Mik cartons (carton/plastic/aluminium) 16.14 83.9 96.4 2.376 50.6 8.7 1.03 0.72 0.03 0.01 omposite Mik cartons (carton/plastic/aluminium) 16.14 83.9 9.7 16.97 4.7 2.2 0.452 0.393</td><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 3.6 0.03 0.07 4.8 biber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 4.06 0.03 0.016 5.16 biber Office paper 8.75 91.3 72.6 82.61 17.39 33.3 20.6 0.188 7.77 0.07 0.01 5 biber Other clean paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 4.39 0.06 0.01 5 biber Other clean cardon containers 22.66 7.77 86.6 13.4 14.97 40.9 15.1 0.206 2.62 0.03 0.01 5.5 biber Other clean cardboard 16.54 83.2 98.8 1.2 2.1325 46 10.5 6.28 0.0727 0.03 0.01 7.3 omposite Milk cartons (cardon/plastic/aluminium) 16.14 83.9 94.</td><td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 12.5 0.173 3.6 0.03 0.07 4.8 0.0899 Books, phone books 4.5 95.5 82.2 17.8 15.06 40.4 21.4 0.203 40.6 0.03 0.016 5.16 0.0699 Biber Office paper 8.75 91.3 79.3 20.7 12.53 37.3 20.6 0.18 7.7 0.07 0.01 5 0.0118 Biber Other clean paper 7.37 92.6 82.61 17.39 13.15 38.1 21.9 0.192 4.39 0.06 0.01 5 0.073 Biber Other clean cardboard 165.2 83.5 86 1.4 150.8 40.7 15.2 0.205 3.09 0.02 0.02 5.4 0.0371 Omposite Mik cartons (carton/plastic/aluminium) 161.4 83.9 90.4 9.6 23.76 50.6 8.7 1.03 0.782 0.01 7.3 0.0472 Omposite Mik c</td></td></t<></td></td></t<>	iber Advertisements 8,75 91,3 72.6 iber Books, phone books 4,5 95.5 82.2 iber Office paper 8,75 91.3 79.3 iber Other clean paper 7,37 92.6 82.61 iber Other clean paper 7,37 92.6 82.61 iber Other clean araboard 16.52 83.5 86 omposite Milk cartons (carton/plastic/aluminium) 16.14 83.9 90.4 omposite Juice cartons (carton/plastic/aluminium) 16.14 83.9 90.4 types 24.47 75.5 91.1 11 85.9 95.6 lastic Dirty cardboard 13.1 86.9 85.1 13.9 14.8 14.11 85.9 93.9 lastic Plastic bottles 10.46 89.5 93.9 14.5 14.11 85.9 94.5 lastic Non-recyclable plastic 7.13 92.9 94.5 17.7 14.8 14.8	iber Advertisements 8,75 91,3 72,6 27,4 iber Books, phone books 4,5 95,5 82,2 17,8 iber Office paper 8,75 91,3 72,6 27,4 iber Office paper 8,75 91,3 72,6 27,7 iber Other clean paper 7,37 92,6 82,61 17,39 iber Other clean carbon containers 22,26 77,7 86,6 13,4 iber Other clean carbonard 16,52 83,5 86,6 14 omposite Milk cartons (carton/plastic/aluminium) 16,14 83,9 90,4 9,6 typer 2,447 75,5 91,1 8,9 9 9,4 9,6 typer 2,447 75,5 91,1 8,9 9,6 14,9 9 14,9 9 14,9 14,1 8,9 9,6 1,4 14,9 14,1 8,9 9,6 1,1 14,9 14,1 14,9	Ber Advertisements 8.75 91.3 72.6 27.4 13.05 Bocks, phone books 4.5 95.5 82.2 17.8 15.06 Ber Office paper 8.75 91.3 79.3 20.7 12.33 Biber Office paper 8.75 91.3 79.3 20.7 12.33 Biber Office paper 8.75 91.3 79.3 20.7 12.53 Biber Office clean paper 7.37 92.6 82.61 17.39 13.15 Other clean cardboard 165.2 83.5 86 14 15.08 omposite Mik cartons (carton/plastic/aluminium) 16.14 83.9 90.4 9.6 23.76 Uther Kitchen towels 46.86 53.1 97.3 2.7 16.97 Iber Dirty paper 24.47 75.5 91.1 8.9 16.17 Iber Dirty cardboard 13.1 86.9 85.1 14.9 16.97 Iastic </td <td>Ber Advertisements 8.75 91.3 72.6 27.4 13.05 34.4 iber Bocks, phone books 4.5 95.5 82.2 17.8 15.06 40.4 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Ma... Proj... Ext... Material transfer Process exchanges Documentation LCI Charact. imp. Norm. imp. Weight. imp. Composition

"Elementary exchanges" catalogue (4b):

le View Catalogu	ies						De	evelopment
aterial pro 🔻 🖡 🗙	Scenario 1	Elementary exchanges						1
Material general *	1						Search	
Residual hou	Comparte	ment Sub-compartment	Name	Unit	Formula	CasNumber		
Garden wast	× Z air	indoor	Carbon monoxide, from soil or biomass stock	101100	Torritola	000630-08-0		
Residual hou	X 2 air	indoor		kg		000074-82-8		-
Residual hou	X air	low population density, long-term		kg	C4H10O2	000110-63-4		
Municipal wa	X Z air	low population density, long-term		kg	C4H1002	000071-41-0		
Municipal an	× Z air	low population density, long-term		kg	C5H10	000109-67-1		
0 Other	X Z air	low population density, long-term		kg	C3H9NO	002749-11-3		
ource separatic	X Z air	low population density, long-term		kg	C6H14O2	000096-14-0		
Collection	X Z air	low population density, long-term		kg	C4H100	000078-83-1		
Transport	X / air	low population density, long-term		kg	C5H10	000513-35-9		
MRF	X Z air	low population density, long-term		kg	C7H5NO4	000552-16-9		
Mixed waste Lar	X / air	low population density, long-term		kg	C3H8O	000067-63-0		
Material recyclin Thermal treatme	X 🕜 air	low population density, long-term		kg	C5H12O	000123-51-3		
andfill mineral	X 🖓 air	low population density, long-term		kg	C6H12O	000108-10-1		
	X 🖓 air	low population density, long-term		kg	C12H10	000083-32-9		
Ash treatment	X 🖓 air	low population density, long-term		kg	CH3CHO	000075-07-0		
Biological treatn	X 🖓 air	low population density, long-term		kg		000064-19-7		
Use-on-land	X 2 air	low population density, long-term		kg	C2HO2F3	000076-05-1		
emplate	X Z air	low population density, long-term		kg		000067-64-1		
Generation	X Z air	low population density, long-term		kg	C2H3N	000075-05-8		
Energy g Material	X 🖓 air	low population density, long-term		kg	C3H4O	000107-02-8		
	X 🖓 air	low population density, long-term		kg	C3H4O2	000079-10-7		
Material	X Z air	low population density, long-term		kBq				
General	× Z air	low population density, long-term		kBa				*
Basic Substance			🦊 A	dd new	elementary ex	change		
Substance								
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Addition +								
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"Impact categories" catalogue (4c):

liew Catalogues						Developmen
	Scenario 1 Impact	categories				
erial generat *						
Residual hou In	npact category:	PCC 2007, climate change, GV	VP 100a 🔹 Edi	t selected Create new	Import category	
Garden wast	+ Add new elementar	y exchange				
Residual hou	Compartment	Sub compartment	Name	Unit	Characterisation factor	
Aunicipal wa 🕺	air	non-urban air or from high	Carbon dioxide. from soil	c ka	1	
	air	urban air close to ground			1	
	air	low population density, lor			1	
eparatic 🗱	air		Carbon dioxide, from soil		1	
	air	lower stratosphere + uppe			1	
τ 🕺	air	non-urban air or from high		kg	1	
	air	urban air close to ground	Carbon dioxide, fossil	kg	1	
aste Lar 🛛 🗱	air	low population density, lor	Carbon dioxide, fossil	kg	1	
recyclin 🗱	air	unspecified	Carbon dioxide, fossil	kg	1	
treatme 🗏 🐹	air	lower stratosphere + uppe	Carbon dioxide, fossil	kg	1	
nineral 🛛 🗱	air	lower stratosphere + uppe	Carbon monoxide, fossil	kg	1.571	
ment 🛛 🗱	air	unspecified	Carbon monoxide, fossil	kg	1.571	
l treatn 🛛 🗱	air	low population density, lor	Carbon monoxide, fossil	kg	1.571	
and X	air	urban air close to ground	Carbon monoxide, fossil	kg	1.571	
×	air	non-urban air or from high	Carbon monoxide, fossil	kg	1.571	
ation 🗱	air	lower stratosphere + uppe	Methane, bromo-, Halon 1	. kg	5	
iergy g 🛛 💥	air	unspecified	Methane, bromo-, Halon 1	. kg	5	
aterial 🛛 🗱	air	low population density, lor	Methane, bromo-, Halon 1	. kg	5	
laterial 🛛 🗱	air	urban air close to ground	Methane, bromo-, Halon 1	. kg	5	
al 🗶	air	non-urban air or from high	Methane, bromo-, Halon 1	. kg	5	
ic 🗶	air	lower stratosphere + uppe	Methane, dichloro-, HCC-3	3 kg	8.7	
stanc 🖉	air	unenacified	Mathana dichlara, HCC.	2 ka	07	

"Methods" catalogue (4d):

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0 Other	Impact category Normalisation factor	Weighting factor
b Source separatic	K IPCC 2007, climate change, 7730	1
Collection	K EDIP w/o LT, environmenta 0.0205	1
Transport	ReCiPe Midpoint (H) w/o L 52.9	1
MRF	ReCiPe Midpoint (H) w/o L 49.88	1
Mixed waste Lar	K CML 2001 w/o LT, eutroph 356	2
 P Material recyclin ■ Thermal treatme 	ReCiPe Midpoint (H) w/o L 0.69	1
Landfill mineral	Rearticulate matter, respirat 4.71	1
Ash treatment	X USEtox w/o LT, human toxi 3.25E-05	1
Biological treatn	X USEtox w/o LT, human toxi 0.000814	1
Use-on-land	X USEtox w/o LT, ecotoxicity 5060	1
 Template 	K CML 2001 w/o LT, resource 0.95	1
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"Interfaces" catalogue (4e):

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al hou 🎾	🕼 air	low population density, long-term	26					
pal wa	🕼 air	lower stratosphere + upper troposphere	26					
oal ar	🕼 air	non-urban air or from high stacks	26					
	🕼 air	unspecified	26					
	🕼 air	urban air close to ground	26					
	🕼 direct human uptake		0					
	🕼 economic	primary production factor	0					
	🕼 natural resource	biotic	0					
	🕼 natural resource	in air	0					
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stanc	💢 air	unspecified		Carbon dioxide, fossil	44 / 12	kg	kg C fossil	
istanc	💢 air	unspecified		Silver	1	kg	kg Ag	
ss trai	🗙 air	unspecified		Aluminium	1	kg	kg Al	
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"Constants" catalogue (4f):

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Residual hou	X Volume_gas		L/mol											
Residual hou	H2O_heating		MJ/kg											
Municipal wa	CH4_LHV	37	MJ/Nm3											
D Municipal an	X [2] M_C	12.011	g/mol											
0 Other	X [2] M_H	1.008	g/mol											_
Source separatic	× [2] M_N	14.007	g/mol											
Collection	X [M_0	15.999	g/mol											-
Transport	×⊘ M_P	30.974	g/mol											
MRF	X [] M_CO2	44.01	g/mol											
D Mixed waste Lar	X [2] M_CH4	16.04	g/mol											_
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"Material properties" catalogue (4g):

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						operties	aterial pro	Scenario 1 Ma
	Display - solids	Display - liquid	Display - gas	Display - default	Selected for calculations	Comment	Unit	Name
		4			V		kg	Water
		1			V	Calculated as VS+Ash	kg	TS
		1		v	1		kg	VS
	V	1					kg	Ash
		V			1	Calculated as H2O+VS+Ash	kg	Total Wet Weight
		7	1		V	Lower heating value (dry) for solids	MJ	Energy
							m^3	CH4 potential
			V	V	1		kg	C bio
		[]				C bio anaerobically degradable	kg	C bio and
		1	J		1		kg	C fossil
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PART III: DOCUMENTATION OF CALCULATIONS

This document was used to communicate with the development team and explain how calculations should be implemented. It uses simple words and lots of examples to illustrate the calculations happening in each template process.

In a first section, the different calculations of output flow compositions are presented. The second section describes the general LCA calculations happening in all processes, related to data in the "Process exchanges" tab, i.e. external processes and process-specific emissions. The third section presents the input-specific emissions calculated in 4 material processes whose "Material transfer" tab produces input-specific emissions.

1 Material composition calculations

1.1 Material generation

In this process, the user defines a TotalAmount and the composition in terms of fractions (called "percent" here). Data about each fraction are taken in the library of material fractions.

For each material fraction,

- water (kg) = water% (fraction)/100 *percent(fraction)/100 *TotalAmount (kg)
- vs(kg) = VS%(fraction))/100 * percent(fraction))/100 *TotalAmount(kg)
- ash(kg) = ash%(fraction))/100 * percent(fraction))/100 *TotalAmount(kg)
- energy (MJ) = energy%(fraction) * TS%(fraction)/100 *percent(fraction))/100
 *TotalAmount(kg)
- for all other material properties: materialproperty(kg) = materialproperty%(fraction))/100 * TS%(fraction))/100 * percent(fraction))/100 *TotalAmount(kg)

where e.g. "ash%" is the ash content of the fraction in the library of material fractions.

Total wet weight and TS are calculated as usual, respectively as the sum of TS and water, and the sum of VS and ash. Figure S2 shows an example of material generation process.

Scenario 2	Scenario 1 Impact c	ategories /	LCIA N	/lethods	Material f	ractions											
Category	Fraction name	Water (%)	TS (%)	VS (%TS)	Ash (%TS)	Energy (MJ/kgTS)	C bio (%TS)	C bio and (%TS)	C fossil (%TS)	Ca (%TS)	CI (%TS)	F (%TS)	H (%TS)	K (%TS)	N (%TS)	Na (%TS)	C
Crganics \	Vegetable food waste	76.99	23	94.8	5.2	18.3	47.5	42.3	0.239	0.555	0.56	0.01	6.6	1.27	1.9	0.312	39
Organics	Animal food waste	57.14	42.9	91.3	8.7	24.55	55.4	36	1.13	4.09	1.63	0.01	7.9	0.533	7	1.08	18
Fiber I	Newsprints	12.95	87	91.8	8.2	17.07	44.6	7.3	0.224	1.11	0.03	0.01	5.7	0.0672	0.1	0.0246	44
Fiber !	Magazines	6.2	93.8	66	34	11.47	34	8	0.171	10.1	0.03	0.01	4.2	0.0686	0.1	0.0898	2
Fiber /	Advertisements	8.75	91.3	72.6	27.4	13.05	34.4	12.5	0.173	3.6	0.03	0.07	4.8	0.0899	0.3	0.128	32
Fiber E	Books, phone books	4.5	95.5	82.2	17.8	15.06	40.4	21.4	0.203	4.06	0.03	0.016	5.16	0.0699	0.12	0.0545	38
Fiber (Office paper	8.75	91.3	79.3	20.7	12.53	37.3	20.6	0.188	7.77	0.07	0.01	5	0.0118	0.1	0.0774	36
Fiber (Other clean paper	7.37	92.6	82.61	17.39	13.15	38.1	21.9	0.192	4.39	0.06	0.01	5	0.073	0.2	0.0977	38
🖡 Fiber 🛛 🖡	Paper and carton contain	22.26	77.7	86.6	13.4	14.97	40.9	15.1	0.206	2.62	0.03	0.04	5.6	0.0374	0.2	0.0476	39
Fiber (Other clean cardboard	16.52	83.5	86	14	15.08	40.7	15.2	0.205	3.09	0.02	0.02	5.4	0.0397	0.1	0.0416	39
Composite	Milk cartons (carton/plast	16.84	83.2	98.8	1.2	21.325	46	10.5	6.28	0.0727	0.03	0.01	7.3	0.0472	0.4	0.15	38
Composite J	Juice cartons (carton/plas	16.14	83.9	90.4	9.6	23.76	50.6	8.7	1.03	0.782	0.11	0.01	7.7	0.0571	0.2	0.174	30
Cther H	Kitchen towels	46.86	53.1	97.3	2.7	16.97	44.7	25.2	0.452	0.393	0.26	0.01	6.3	0.151	0.8	0.206	44
🕻 Fiber 🛛 🛛	Dirty paper	24.47	75.5	91.1	8.9	18.17	44.6	15	0.91	1.09	0.48	0.02	6.5	0.119	0.3	0.109	38
		4															
							Add new ma	terial fraction									
aterial transfer																	
Aaterial genera	ation																
laterial g	eneration: amou	int and	fract	ions													
otal amount (kg	a) 30																
Include upstre	,,,																
🔶 Add fracti	on Normalise comp	osition to 10	00%														
Material frac	ction %																
Vegetable fo	ood waste 70																

Figure S2: Material transfer of a "Material generation" process and catalogue of material fractions

The output is (Figure S3):

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- for fraction "vegetable food waste":
 - water: 76.99/100 * 70/100 * 30 kg = 16.169 kg
 - VS: 94.8/100*23/100*70/100*30 kg = 4.579 kg
 - o ash: 5.2/100 *23/100 *70/100 *30 kg =0.251 kg
 - o energy: 18.3*23/100*70/100*30 kg = 88.389 MJ
 - o C bio: 47.5/100 *23/100 *70/100 *30 kg = 2.294 kg
 - o ...
 - for fraction "office paper":
 - o water: 8.75/100 * 30/100 * 30 kg = 0.7875 kg
 - o VS: 79.3/100*91.3/100*30/100*30 kg = 6.516 kg
 - o ash: 20.7/100 *91.3/100 *30/100 *30 kg =1.701 kg
 - o energy: 12.53*91.3/100*30/100*30 kg = 102.96 MJ
 - C bio: 37.3/100 *91.3/100 *30/100 *30 kg = 3.065 kg

omposition	Adv. Waste Generation												
Display Default	- Adv. Waste Generation												
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	
Sum	30	13.047	16.96	11.09	1.952	191.3	5.359	3.736	0.02699	0.6653	0.0328	0.001305	
Vegetable food waste	21	4.83	16.17	4.579	0.2512	88.389	2.294	2.043	0.01154	0.02681	0.02705	0.000483	0
Office paper	9.005	8.217	0.7875	6.516	1.701	103	3.065	1.693	0.01545	0.6385	0.005752	0.0008217	0

Figure S3: Material composition of the output of the "Material generation" process

1.2 Energy generation

The user defines a TotalAmount and the composition in terms of fractions (called "percent" here). Data about each fraction is taken in the library of material fractions.

For each material fraction,

- energy (MJ) = percent(fraction) /100 *TotalAmount(MJ)
- vs(kg) = VS%(fraction))/100 * percent(fraction))/100 *TotalAmount(MJ) /energy%(MJ/kg)
- ash(kg) = ash%(fraction))/100 * percent(fraction))/100 *TotalAmount(MJ) /energy%(MJ/kg)
- water (kg) = water%(fraction) / TS%(fraction) *percent(fraction)/100 *TotalAmount (MJ) /energy%(MJ/kg)
- for all other material properties: materialproperty(kg) = materialproperty%(fraction))/100 * percent(fraction))/100 *TotalAmount(MJ) / energy%(MJ/kg)

where e.g. "ash%" is the ash content of the fraction in the library of material fractions.

Total wet weight and TS are calculated as usual, respectively as the sum of TS and water, and the sum of VS and ash.

Material tra	anster		
Energy g	eneration		
Energy	generation: a	mour	nt and fractions
Total amo	unt (MJ) 30		
🔲 Include	upstream impacts		
🔶 Ad	d fraction Normal	ise comp	osition to 100%
Mass	Material fraction	%	
* 🗸	Vegetable food waste	70	
X	Office paper	30	

Figure S4: Material transfer of a "Material generation" process and catalogue of material fractions

Vegetable food waste is:

- Energy = 70/100 * 30 MJ = 21 MJ
- TS = (70/100 * 30 MJ) / 18.3 MJ/kg = 1.148 kg
- VS = (70/100 *30 MJ) /18.3 MJ/kg *94.8/100 = 1.088 kg
- Ash = (70/100 *30 MJ) / 18.3 MJ/kg * 5.2 / 100 = 0.0597 kg
- Water = 76.99/23.01 *70/100*30 MJ /18.3 MJ/kg = 3.841 kg

Because the tickbox "Mass" is unticked for "Office paper", this fraction has only:

- Energy = 30/100*30 MJ = 9 MJ

nergy generation -	Adv. Energy Generation												
Display Default	•												
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (k
Sum	4.989	1.148	3.841	1.088	0.05967	30	0.5451	0.4854	0.002743	0.006369	0.006426	0.0001148	0.07
Vegetable food waste	4.989	1.148	3.841	1.088	0.05967	21	0.5451	0.4854	0.002743	0.006369	0.006426	0.0001148	0.075
Office paper	0	0	0	0	0	9	0	0	0	0	0	0	0

Figure S5: Material composition of the output of the "Material generation" process

1.3 Material generation – manual

In this process, the user defines the number of fractions and the amounts of material properties directly. So the only thing to calculate is "Total solids (TS)" equal to VS+ash, and "Total wet weight (TWW)" equal to TS+waterContent.

1.4 Basic

Output = input.

1.5 Substance transfer per fraction

The number of outputs is determined by the user. The user can define the name of the output by right clicking on the column header in the table "Material transfer". Each output has the same material fractions as the input (in terms of numbers and names).

For each output, for each fraction, for each material property,

outputNumber.fraction.property = input.fraction.property*TC(property, fraction, outputNumber)/100

where TC is a transfer coefficient input by the user in the table of "Material transfer" in an output column, in a material fraction line.

- If the fraction doesn't exist in the table, the calculation uses the "default" line".
- Also, by default, all TC are equal to zero in newly-created output columns.
- For each fraction line, the TC to the last output (called "Residues") is defined as 100 minus the TC of the other columns, so when the other TC are not defined, 100% of the material property go to the output "Residues".
- If a "degradation" output is added, a column "Degradation" is added which works like any other column, but a special cross-output is displayed and this output cannot be connected to any process. Note that only one degradation output can be created.

Example: For an input of 30 kg of 70% vegetable food waste and 30% office paper, we have the input flow specified in Table S1.

Fracti on name	Total Wet Weight (kg)	TS (kg)	Wa ter (kg)	VS (kg)	Ash (kg)	Ener gy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	Cl (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)	0 (kg)	P (kg)	S (kg)	Ag (kg)	Al (kg)	As (kg)
Veget able food waste	21	4.8 3	16. 17	4.5 79	0.2 512	88.38 9	2.2 94	2.043	0.01 154	0.0 268 1	0.0 270 5	0.0 004 83	0.3 188	0.0 613 4	0.0 917 7	0.0 150 7	1.9 08	0.0 111 6	0.0 088 87	0	0.0 049 75	1.2 65E -06
Office paper	9.005	8.2 17	0.7 875	6.5 16	1.7 01	103	3.0 65	1.693	0.01 545	0.6 385	0.0 057 52	0.0 008 217	0.4 109	0.0 009 696	0.0 082 17	0.0 063 6	3.0 16	0.0 003 139	0.0 052 84	0	0.0 107 6	1.7 5E- 06

Table S1: Material composition of the input flow

We bring this to a "substance transfer per fraction" process with transfer coefficients specified only for VS and Hg:

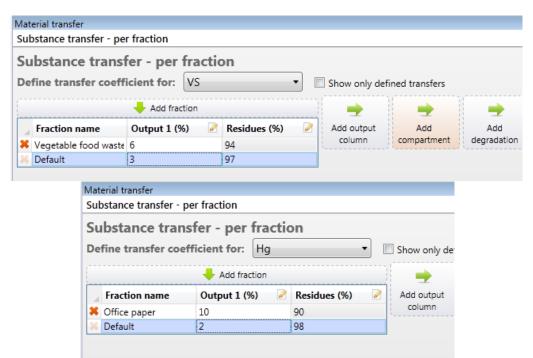


Figure S6: Material transfer for the "substance transfer per fraction" process

Output1 has:

- for fraction "vegetable food waste":
 - VS: 4.579 kg * 6/100 = 0.275 kg
 - Hg: 9.66E-8 kg * 2/100 = 1.932 E-9 kg
 - o all others: 0
- for fraction "office paper":
 - \circ VS: 6.516 kg * 3/100 = 0.195 kg
 - Hg: 2.925 E-7 kg * 10/100 = 2.925 E-8 kg
 - o all others: 0

Output "residues" has:

- for fraction "vegetable food waste":
 - o VS: 4.579 kg * 94/100 = 4.304 kg

- o Hg: 9.66E-8 kg * 98/100 = 9.47 E-8 kg
- o all others equal to the fraction "vegetable food waste" in the input
- for fraction "office paper":
 - VS: 6.516 kg * 97/100 = 6.321 kg
 - o Hg: 2.925 E-7 kg * 90/100 = 2.632 E-7 kg
 - o all others equal to the fraction "office paper" in the input

č																						
Display Def	efault	•																				
Fraction nam	me	Total Wet Weight (I	(g) TS (g) Water	r (kg) 1	/S (kg)	Ash (kg)	Energy (MJ)	C bio (kg	g) C bio and (k	g) C fossil (kg) Ca (kg)	CI (kg)) F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	P (kg)	S (kg)	Hg (kg)
Sum		0.4702	0.47	02 0	(.4702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.118E-0
Vegetable for	ood waste	0.2747	0.274	7 0	0	2747 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.932E-09
Office paper	r i	0.1955	0.195	5 0	0	1955 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.925E-08
nposition		r fraction - Residues						<u>.</u>													• ậ	1
mposition ubstance tran	ansfer - per	r fraction - Residues	-										-d-								▼ ậ	1
mposition Ibstance tran	ansfer - per	ba yar krasur																			• ų	1
omposition ubstance tran	ansfer - per fault	r fraction - Residues	TS (kg)	Water (kg)	VS (kg)	Trees are			C bio (and (kg)	C fossil (kg) Ca		F (kg)	H (kg)	K (kg)	N (kg)	Na (kg	i) O (k	j) P (kg)	S (kg) Hi	▼ ‡ g (kg)	
omposition ubstance tran Display Defa Fraction name	ansfer - per fault ne T	r fraction - Residues	TS (kg)			Trees are) Energy		and (kg)	C fossil (kg) Ca 0.02699 0.6	kg) CI (kg)			K (kg) 0.06231	N (kg)			-				
omposition ubstance tran Display Defa	ansfer - per fault ne T 2	r fraction - Residues Total Wet Weight (kg) 29.53	TS (kg) 12.58	Water (kg) 16.96	VS (kg)	Ash (kg) Energy (MJ)	5.359	and (kg) 3.736	1.55	kg) CI (kg)	0.001305	0.7296				43 4.92	3 0.0114	7 0.014	417 3.	g (kg)	3

Figure S7: Material composition of output1 and residues

1.6 Substance transfer default

This process is very similar to "substance transfer per fraction" except that it doesn't allow the user to specify different TC for different material fractions. The number of outputs is determined by the user. The user can define the name of the output by right clicking on the column header in the table "Material transfer". Each output has the same material fractions as the input (in terms of numbers and names).

For each output, for each fraction, for each material property,

outputNumber.fraction.property = input.fraction.property*TC(property, outputNumber)/100

where TC is a transfer coefficient input by the user in the table of "Material transfer" in an output column.

- It is the same transfer coefficients for all fractions.
- Also, by default, all TC are equal to zero in newly-created output columns.
- The default output is the "Degradation" output which cannot be removed and which cannot be connected to any process.
- The TC to the last output (called "Degradation") is defined as 100 minus the TC of the other columns, so when the other TC are not defined, 100% of the material property go to the output "Degradation".

The input composition is specified in Table S1 and this input is brought this to the "substance transfer default" process specified in Figure S8.

sui	ostance transfer - de	etault			
Su	ibstance trans	fer - default			
De	fine transfer coef	ficient (applied to a	all material fraction	ns)	
		Add material property		i 🔶	-
	Material property	Add material property Output 1 (%)	Degradation (%)	Add output	🚽 Add
*	Material property VS		Degradation (%) 97	Add output column	Add compartment

Figure S8: Material transfer for the "substance transfer default" process

Output1 has:

- for fraction "vegetable food waste":
 - o VS: $4.579 \text{ kg} \times 3/100 = 0.137 \text{ kg}$
 - Hg: 9.66E-8 kg* 2/100 = 1.932 E-9 kg
 - o all others: 0
- for fraction "office paper":
 - VS: 6.516 kg * 3/100 = 0.195 kg
 - o Hg: 2.925 E-7 kg * 2/100 = 5.85 E-9 kg
 - o all others: 0

And the output "Degradation" cannot be viewed.

omposition Substance transfer ·	default - Output 1																			
Display Default	•																			
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	P (kg)	S (kg)	Hg (kg)
Sum	0.3328	0.3328	0	0.3328	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7.783E-0
Vegetable food was	e 0.1374	0.1374	0	0.1374	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.932E-09
Office paper	0.1955	0.1955	0	0.1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.851E-09

Figure S9: Material composition of output1

1.7 Mass transfer to outputs

This process is similar to "substance transfer per fraction" but each output gets a transfer coefficient for the total mass, not specifically for each material property. The number of outputs is determined by the user. The user can define the name of the output by right clicking on the column header in the table "Material transfer". Each output has the same material fractions as the input (in terms of numbers and names).

For each output, for each fraction, for each material property,

outputNumber.fraction.property = input.fraction.property*TC(fraction, outputNumber)/100

where TC is a transfer coefficient input by the user in the table of "Material transfer" in an output column, in a material fraction line.

- If the fraction doesn't exist in the table, the calculation uses the "default" line".
- Also, by default, all TC are equal to zero in newly-created output columnss.
- For each fraction line, the TC to the last output (called "Residues") is defined as 100 minus the TC of the other columns, so when the other TC are not defined, 100% of the material property go to the output "Residues".

The input composition is specified in Table S1 and this input is brought this to a "mass transfer" process with transfer coefficients specified in Figure S10.

/laterial transfer Mass transfer to output	s				
Mass transfer to	outputs				
Define transfer coeff	icients to each	out	put column		
	🕂 Add fraction				-
Fraction name	Output 1 (%)	2	Residues (%)	2	Add output
X Vegetable food waste	40		60		column
💥 Default	10		90		

Figure S10: Material transfer for the "substance transfer default" process

Output1 has:

- for fraction "vegetable food waste": 40% of input of "vegetable food waste"
- for fraction "office paper": 10 % of input of "office paper".

Output "residues" has:

- for fraction "vegetable food waste": 60% of input of "vegetable food waste"
- for fraction "office paper": 90 % of input of "office paper".

lass transfer to outp	uts - Output 1													
Display Default	•													
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg
Sum	9.3	2.754	6.546	2.483	0.2706	45.65	1.224	0.9865	0.006162	0.07457	0.01139	0.0002754	0.1686	0.02
Vegetable food waste	8.399	1.932	6.467	1.832	0.1005	35.36	0.9177	0.8172	0.004617	0.01072	0.01082	0.0001932	0.1275	0.024
Office paper	0.9005	0.8217	0.07875	0.6516	0.1701	10.3	0.3065	0.1693	0.001545	0.06385	0.0005752	8.217E-05	0.04109	9.696

lass transfer to outp														
Display Default	•													
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)
Sum	20.7	10.29	10.41	8.612	1.682	145.7	4.135	2.749	0.02083	0.5907	0.02141	0.001029	0.561	0.03768
Vegetable food waste	12.6	2.898	9.701	2.747	0.1507	53.03	1.377	1.226	0.006926	0.01608	0.01623	0.0002898	0.1913	0.0368
Office paper	8.104	7.395	0.7088	5.864	1.531	92.66	2.758	1.523	0.0139	0.5746	0.005177	0.0007395	0.3698	0.000872

Figure S11: Material composition of output1 and residues

1.8 Change of energy content

There is one output with all material properties equal to the input, except for the output's energy content which is recalculated based on the following formula.

The principle is that the "energy content" is equal to the energy content of the input added to amounts depending on selected material properties. For example, the energy content is decreased of 2 MJ per kg of water content and decreased of 0.1 MJ per kg of Ash.

For each material fraction,

where percent is the value given by the user between 0 and 100, which can be specified for each material fraction.

The input composition is specified in Table S1 and this input is brought this to a "change of energy content" process where the energy content is decreased of 3 MJ per kg of water content for all fraction except for "vegetable food waste" for which it is 2, and it is also decreased of 0.1 MJ per kg of Ash for all fractions.

Material transfer		Material transfer						
Change of energy content		Change of energy content						
Change of energy content Energy lost due to: Water	Change of energ Energy lost due to:	y content Ash	•					
Fraction name Change in energy (MJ/unit)		+ Add fraction						
× Vegetable food waste	-2	Fraction name		Change in energy (MJ/unit)				
🗶 Default	× Default -3			-6				

Figure S12: Material transfer of "Change of energy content"

So the calculation of the energy content is:

- for vegetable food waste, energy content (kg) = energy content (kg) + (-2)*water(kg) + (-0.1) *ash(kg) = 88.389 + (-2)*16.17 + (-6)*0.2512 = 54.54 MJ
- for office paper, energy content (kg) = energy content (kg) + $(-3)^*$ water(kg) + $(-0.1)^*$ ash(kg) = $103 + (-3)^* 0.7875 + (-6)^* 1.701 = 90.43 \text{ MJ}$

hange of energy cor	ntent - Rejects													
Display Default	•													
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	Cl (kg)	F (kg)	H (kg)	K (kg)
Sum	30	13.047	16.96	11.09	1.952	144.9	5.359	3.736	0.02699	0.6653	0.0328	0.001305	0.7296	0.06231
Vegetable food waste	21	4.83	16.17	4.579	0.2512	54.55	2.294	2.043	0.01154	0.02681	0.02705	0.000483	0.3188	0.06134
Office paper	9.005	8.217	0.7875	6.516	1.701	90.39	3.065	1.693	0.01545	0.6385	0.005752	0.0008217	0.4109	0.000969

Figure S13: Material composition of the output

1.9 No output

No output.

1.10 Water content

There is one output with all material properties equal to the input, except for the output's water content which is recalculated based on the following formula.

For each material fraction,

output.fraction.water (kg) = input.fraction.TS (kg) * (percent(fraction) / (100-percent(fraction)))

where percent is the value given by the user between 0 and 100, which can be specified for each material fraction.

Of course the Total Wet Weight is changed, as it calculated as the sum of water and TS.

The input composition is specified in Table S1 and this input is brought this to a "water content" process and say that the water content should be 50% for vegetable food waste and 10% by default.

Material transfer Water content							
Water content							
Define the new water o	ontent						
🔶 Ad	d fraction						
Fraction name	% of wet weight						
X Vegetable food waste	50						
× Default 10							

Figure S14: Material transfer of "Water content"

So the calculation of the water content is:

- for vegetable food waste, water (kg) = TS (kg) * (50 /(100-50)) = 4.83 kg *(50/(100-50)) = 4.83 kg
- for office paper, water (kg) = TS (kg) * (10 / (100-10)) = 8.217 kg * (10 / (100-10)) = 0.913 kg

omposition															-	• ₽ >
Vater content - Out	put															
Display Default	•															
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	Cl (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (
Sum	18.79	13.047	5.743	11.09	1.952	191.3	5.359	3.736	0.02699	0.6653	0.0328	0.001305	0.7296	0.06231	0.09999	0.0
Vegetable food waste	9.66	4.83	4.83	4.579	0.2512	88.389	2.294	2.043	0.01154	0.02681	0.02705	0.000483	0.3188	0.06134	0.09177	0.01
Office paper	9.13	8.217	0.913	6.516	1.701	103	3.065	1.693	0.01545	0.6385	0.005752	0.0008217	0.4109	0.0009696	0.008217	0.00

Figure S15: Material composition of the output

1.11 Addition of substances

There is one output with all material properties equal to the input, except for the material properties selected in the table of Material transfer. The calculations depend on which radio button has been selected by the user.

For each material property in the table, for each material fraction,

- if "solid material":

output.fraction.selectedMaterialProperty = input.fraction.selectedMaterialProperty + amount(selectedMaterialProperty)*input.fraction.TotalWetWeight /10^6

- if "gas":

output.fraction.selectedMaterialProperty = input.fraction.selectedMaterialProperty + amount(selectedMaterialProperty)* (input.fraction.ch4 + input.fraction.co2) /10^3

if "liquid":

output.fraction.selectedMaterialProperty = input.fraction.selectedMaterialProperty + amount(selectedMaterialProperty)*input.fraction.WaterContent /10^6

- if "energy":

output.fraction.selectedMaterialProperty = input.fraction.selectedMaterialProperty + amount(selectedMaterialProperty)*input.fraction.EnergyContent /10^3

where "amount" is the value given by the user in the table, for the specific material property.

The input composition is specified in Table S1 and this input is brought this to a "addition of substances" process with in the table "Hg; 2".

If we select "solid":

Addition of substance	s	
Addition of sub		
Define substances a	Add substance	Add substance based on:
Substance name	Amount	 gas (g/m³, based on volume of CH₄ and CO₂)
🗱 Hg	0.02	 gas (g/m , based on volume of CR4 and CO2) liquid (mg/L, based on water content)
		energy (g/MJ, based on energy content)

Figure S16: Material transfer of "Addition of substance" in the case of "solid" selection

The output is the same as the input except for Hg, which is:

- for vegetable food waste: 9.66E-8 kg + 0.02 g /10⁶ g *21kg = 0.966E-7 kg + 4.2E-7 kg = 5.16E-7 kg.
- for office paper: $2.925E-7 \text{ kg} + 0.02 \text{ g}/10^{6} \text{ g} * 9.005 \text{ kg} = 2.925 \text{ E}-7 \text{ kg} + 1.801E-7 \text{ kg} = 4.726 \text{ E}-7 \text{ kg}$.

➢ If we select "gas":

The output is the same as the input including for Hg as CO2 and CH4 are zero. To see the calculation, we add an anaerobic digestion process with yield of 10 % for all fractions (Figure S17).

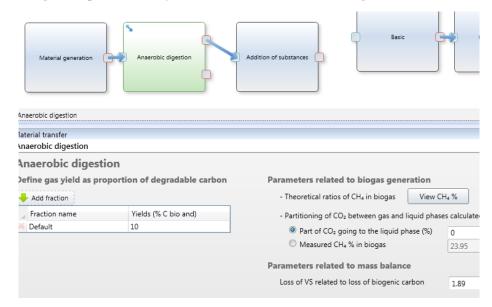


Figure S17: Material transfer of "Anaerobic digestion" process needed in the case of "gas" selection

As explained in subsection 16, the output of this AD process is as shown in Figure S18.

omposition					
naerobic diges	tion - Gas				
Display Gas		•]		
Fraction name	Energy (MJ)	C bio (kg)	C fossil (kg)	CH4 (m^3)	CO2 (m^3)
Sum	0	0.3736	0	0.167	0.5304
Mix	0	0.3736	0	0.167	0.5304

Figure S18: Material composition of the output of the AD process (input of "addition of substance")

So when we 0.02 g/m3 of biogas, the amount of Hg in the fraction mix is: 0.02 g $(0.167 \text{ m})(10^3 \text{ g})(10^3 \text$

➢ If we select "liquid":

The output is the same as the input except for Hg, which is:

- for vegetable food waste: $9.66\text{E}-8 \text{ kg} + 0.02 \text{ mg}/10^6 \text{ g} *16.17 \text{ kg} = 0.966\text{E}-7 \text{ kg} + 3.234\text{E}-7 \text{ kg} = 4.2\text{E}-7 \text{ kg}$.

- for office paper: $2.925E-7 \text{ kg} + 0.0 \text{ 2mg}/10^{6} \text{ g} * 0.7875 \text{ l} = 2.925 \text{ E}-7 \text{ kg} + 0.1575 \text{ E}-7 \text{ kg} = 3.0825 \text{ E}-7 \text{ kg}$.

If we select "energy":

The output is the same as the input except for Hg, which is:

- for vegetable food waste: $9.66E-8 \text{ kg} + 0.02 \text{ g} / 10^3 \text{ g} * 88.389 \text{ MJ} = 0.966 \text{ E-7 kg} + 1.77 \text{ E-3 kg} = 1.77\text{ E-3 kg}$.

- for office paper: $2.925E-7 \text{ kg} + 0.02 \text{ g} / 10^3 \text{ g} * 103 \text{ MJ} = 2.925 \text{ E}-7 \text{ kg} + 2.06E-3 \text{ kg} = 2.06E-3 \text{ kg}$.

1.12 Emissions to the environment

No output.

1.13 Landfill gas generation

The user needs to specify in the "Material transfer" window of the anaerobic digestion process:

- **k rates** (in yr⁻¹) for each material fraction. They are the speed of decay of the C bio and.
- A factor that the user can change (named **number_of_years** in the rest of the text. The default value is 100.
- A factor that the user can change (named vs_cbio in the rest of the text). The default value is 1.89.

Principle is that we degrade **C** bio and with a first order decay. In consequence **C** bio is degraded. **CO2** and **CH4** are produced as a function of **C** bio and using the **CH4_in_biogas** property. Finally the gas produced has a lot of fractions named "year 1", "year 2", "year 3" etc, and C bio, CH4 and CO2 are calculated for each year and put in the corresponding fractions of the gas output.

Calculation of CH4_in_biogas property

This is exactly the same calculation as in the anaerobic digestion module.

In the calculations of the outputs, we need to calculate for each material fraction a new material property called ch4_biogas, which is in percentage the part of C bio that is transformed into CH4 (the rest being transformed into CO2). This is calculated based on 4 other material properties named "C bio and", "H", O" and "N" with this formula:

Ch4_biogas = $\frac{1}{2} + \frac{168 * H - 21 * O - 36 * N}{112 * Cbioand}$ (the value obtained is between 0 and 1)

Calculations of the gas output

The gas output has the number of fractions defined by the user by "number_of_years". Each fraction is named "Year 1", "Year 2", etc. For year n ($1 \le n \le number_of_years$] these are the properties [NB: C_bio_and, k and ch4_biogas are specific for each fraction] :

- C bio [kg] is: Sum_for_all_material_fractions_of [C_bio_and * exp(- k *(n-1)) *(1-exp(- k))]
- CH4 [m3] is: Sum_for_all_material_fractions_of [C_bio_and * exp(- k *(n-1)) *(1-exp(- k)) * CH4_biogas] *22.4/12

- CO2 [m3] is: Sum_for_all_material_fractions_of [C_bio_and * exp(- k *(n-1)) *(1-exp(- k)) *(1-CH4_biogas)] *22.4/12
- All other properties are zero, including water, VS and ash.

Calculation of the Residues output

The residues output has the same number of material fractions as the input. It is basically defined as equal to the input minus the carbon going to gas. For each material fraction, here are the properties [NB: k is specific to the fraction!]:

- C bio [kg] is: input.c_bio input.c_bio_and * (1-exp(number_of_years * k))
- C bio and is: input.c_bio_and *exp(number_or_years*k)
- VS is: input.vs vs_cbio *input.c_bio_and * (1-exp(number_or_years*k))
- LHV dry [MJ]: input.lhvdry /input.vs *(input.vs vs_cbio *input.c_bio_and * exp(number_or_years*k))
- All other properties are equal to the input.

\triangleright	Example:
·	

Material transfer	Add fraction Add fraction Me k rate (1/yr)		
Landfill gas generation	generation gas generation order decay rate for methane Add fraction name k rate (1/yr) le food waste 0.3		
Landfill gas gener	Add fraction Add fraction h name k rate (1/yr)		
Define 1st order decay	Add fraction k rate (1/yr)	generation	
🔶 Add	fraction	Time horizon of the inventory (in years)	100
Fraction name	k rate (1/yr)	Loss of VS related to loss of C bio (%)	1.89
X Vegetable food waste	0.3		
💥 Default	0.1		

Figure S19: Material transfer of the "Landfill gas generation" process

Gas output, at year n:

- C bio [kg] is: $2.043 * \exp(-0.3 * (n-1)) * (1-\exp(-0.3)) + 1.693 * \exp(-0.1 * (n-1)) * (1-\exp(-0.1))$ so for n=1, 0.6906, and for n=2, 0.5380, and sum=3.736 kg.
- CH4 [m3] is: $(2.043 * \exp(-0.3 * (n-1)) * (1 \exp(-0.3)) * 0.5445 + 1.693 * \exp(-0.1 * (n-1)) * (1 \exp(-0.1)) * 0.5285) * 22.4/12$ so for n=1: 0.6971 m³ and for n=2: 0.5425 m³, and sum=3.746
- CO2 [m3] is: $(2.043 * \exp(-0.3 * (n-1)) * (1-\exp(-0.3)) * (1-0.5445) + 1.693 * \exp(-0.1 * (n-1)) * (1-\exp(-0.1)) * (1-0.5285)) * 22.4/12 so for n=1: 0.5920 m³ and for n=2: 0.4618 m³ and sum=3.227$
- All other properties are zero, including water, VS and ash.

splay Gas		•				
Fraction name	Energy (MJ)	C bio (kg)	C fossil (kg)	CH4 (m^3)	CO2 (m^3)	
Sum	0	3.736	0	3.746	3.227	
/ear 1	0	0.6906	0	0.6971	0.592	
/ear 2	0	0.538	0	0.5425	0.4618	
/ear 3	0	0.4225	0	0.4255	0.3632	=
/ear 4	0	0.3346	0	0.3365	0.2881	Ц
/ear 5	0	0.2675	0	0.2686	0.2306	
′ear б	0	0.2159	0	0.2165	0.1865	
/ear 7	0	0.1759	0	0.1762	0.1522	
/ear 8	0	0.1448	0	0.1448	0.1255	
/ear 9	0	0.1204	0	0.1202	0.1045	
ear 10	0	0.1011	0	0.1008	0.0879	
/ear 11	0	0.08562	0	0.08526	0.07457	
ear 12	0	0.07315	0	0.07275	0.0638	
ar 13	0	0.06299	0	0.06257	0.05501	
'ear 14	0	0.05462	0	0.0542	0.04775	
/ear 15	0	0.04766	0	0.04726	0.04171	

Figure S20: Composition of the gas output from "Landfill gas generation" process

Residues output:

- C bio (vfw) =2.294 + 2.043 * (exp(100 * 0.3) -1) =0.251 kg (ofp) = 3.065 + 1.693 * (exp(- 100 * 0.1) -1) =1.372 kg
- C bio and (vfw) = 2.043 * exp(100 * 0.3)) =1.91E-13 kg (ofp) = 1.693 * exp(- 100 * 0.1)=7.68E-5 kg
- VS (vfw)= 4.579 1.89 * 2.043 * (1-exp(-100*0.3)) = 0.718 kg(ofp) = 6.516 - 1.89 * 1.693 * (1-exp(-100*0.1)) = 3.316 kg
- LHV dry (vfw) = 88.39 /4.579 *(4.579 1. 89 *2.043 * (1-exp(100*0.3)))=13.85 MJ (ofp) = 103/6.156*(6.516 -1.89*1.693*(1-exp(-100*0.1))) =55.49 MJ
- All other properties are equal to the input.

Display Default	T - Nesidues													
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)
Sum	22.94	5.986	16.96	4.034	1.952	66.26	1.623	7.685E-05	0.02699	0.6653	0.0328	0.001305	0.7296	0.0623
Vegetable food waste	17.14	0.9686	16.17	0.7174	0.2512	13.85	0.2512	1.912E-13	0.01154	0.02681	0.02705	0.000483	0.3188	0.06134
Office paper	5.805	5.018	0.7875	3.317	1.701	52.41	1.372	7.685E-05	0.01545	0.6385	0.005752	0.0008217	0.4109	0.00096

Figure S21: Composition of the residues output from "Landfill gas generation" process

1.14 Mass transfer over years

The user specifies for different time periods the routing to different outputs. Each output has as many year fractions as the input.

For each output O, for each year Y,

- Find the period P where Y is located
- all material properties are calculated as: Input.fraction.year.materialProperty *TC(P, O)/100

where TC is the transfer coefficient specified by the user in the table, for the period P and the output O.

In this example we connect this process to a landfill gas generation (Figure S22).

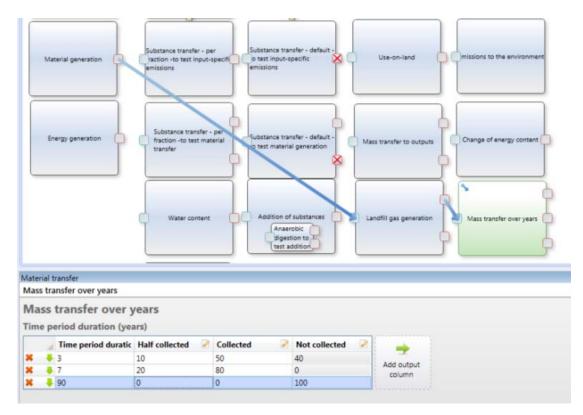


Figure S22: Material transfer of the "Mass transfer over years" process

The input from the landfill gas generation was:

)isplay Gas		•				
Fraction name	Energy (MJ)	C bio (kg)	C fossil (kg)	CH4 (m^3)	CO2 (m^3)	
Sum	0	3.736	0	3.746	3.227	
Year 1	0	0.6906	0	0.6971	0.592	4
Year 2	0	0.538	0	0.5425	0.4618	Π
Year 3	0	0.4225	0	0.4255	0.3632	
Year 4	0	0.3346	0	0.3365	0.2881	1
Year 5	0	0.2675	0	0.2686	0.2306	L
Year 6	0	0.2159	0	0.2165	0.1865	
Year 7	0	0.1759	0	0.1762	0.1522	
Year 8	0	0.1448	0	0.1448	0.1255	
Year 9	0	0.1204	0	0.1202	0.1045	
Year 10	0	0.1011	0	0.1008	0.0879	
Year 11	0	0.08562	0	0.08526	0.07457	
Year 12	0	0.07315	0	0.07275	0.0638	
Year 13	0	0.06299	0	0.06257	0.05501	
Year 14	0	0.05462	0	0.0542	0.04775	
Year 15	0	0.04766	0	0.04726	0.04171	
Year 16	0	0.04182	0	0.04144	0.03664	
Year 17	0	0.03688	0	0.03651	0.03233	
Year 18	0	0.03266	0	0.03231	0.02865	
Year 19	0	0.02902	0	0.0287	0.02547	
Year 20	0	0.02586	0	0.02557	0.02271	

Figure S23: Material composition of the input to the "Mass transfer over years" process

So the calculations for CH4 are:

- For "Half collected" output,
 - Year 1 (period=1): 0.6971 * 10/100 = 0.06971
 - Year 2 (period=1): 0.5425 *10/100 =0.05425

- Year 3 (period=1): 0.4255 *10/100 =0.04255
- Year 4 (period=2): 0.3365 *20/100 =0.0673

ο.

- Year 10 (period=2): 0.1008 *20/100 =0.02016
- Year 11 (period=3): 0.08526 *0/100 =0

ο.

- For "Collected" output,
 - Year 1 (period=1): 0.6971 * 50/100 = 0.3485
 - Year 2 (period=1): 0.5425 *50/100 =0.2712
 - Year 3 (period=1): 0.4255 *50/100 =0.2127
 - Year 4 (period=2): 0.3365 *80/100 =0.2692
 - ο..
 - o Year 10 (period=2): 0.1008 *80/100 =0.0806
 - Year 11 (period=3): 0.08526 *0/100 =0

o ...

- For "Not collected" output,
 - Year 1 (period=1): 0.6971 * 40/100 = 0.2788
 - Year 2 (period=1): 0.5425 *40/100 =0.217
 - Year 3 (period=1): 0.4255 *40/100 =0.1702
 - Year 4 (period=2): 0.3365 *0/100 =0
 - o ...
 - Year 10 (period=2): 0.1008 *0/100 =0
 - Year 11 (period=3): 0.08526 *100/100 =0.08526

o ...

Concerning C bio, the C bio in year 8 of output "Half collected" is: 0.02896.

1.15 Leachate generation

There are always two outputs: leachate and residues.

Leachate has year fractions. The number of year fractions is determined by the user in the field "Time horizon of the inventory (years)". For each year Y:

- The leachate has water (kg) determined thanks to the left table. We need first to find the time period P containing the year Y:

```
leachate.year.water = input.totalWetWeight *netInflitration(P) /(density *height *10^3)
```

where density is the user-defined value given in "Bulk density" field and height is the user-defined value given in the "Height of layer" field

- Substances (kg) determined thanks to the right table: for each substance determined in the table on the right, we need to find the time period P' that contains the year Y and then the amount of substance in that year Y is:

leachate.year.substance = leachate.year.water *concentrate(substance, P')*10^-6 or if easier:

leachate.year.substance = input.totalWetWeight *netInflitration(P) /(density *height *10^3)
*concentrate(substance, P')*10^-6

where density is the user-defined value given in "Bulk density" field and height is the user-defined value given in the "Height of layer" field

Residues is equal to the input minus the substances that go in the leachate. For all substances of input, for each material fraction, the amount in "residues" is:

If input.substance(of_all_fractions =0, then it is zero, else:

 $\label{eq:linear} Input.fraction.substance \ - \ sum_for_all_years \ [leachate.year.water * concentrate(substance, P')*10^{-6}] * input.fraction.substance/input.substance(of_all_fractions))$

When connecting the process described in Figure

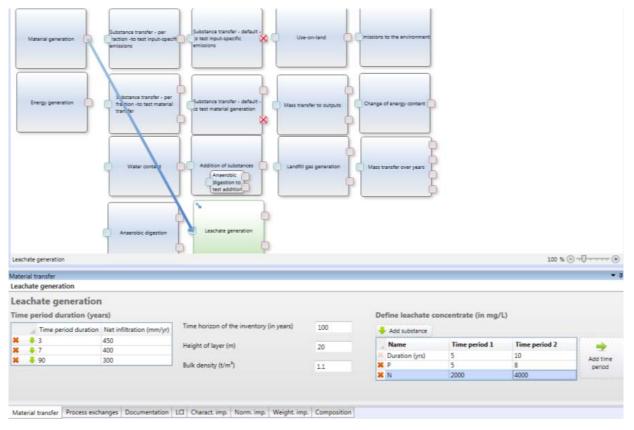


Figure S24: Material transfer of the "Leachate generation" process

So the calculations for water and N are:

- For "Leachate" output, the water is:
 - o Year 1 (period=1): 30 *450 /(1.1 *20 *10^6) =0.614 kg
 - Year 2 (period=1): 30 *450 /(1.1 *20 *10^6) =0.614 kg
 - Year 3 (period=1): 30 *450 /(1.1 *20 *10^6) =0.614 kg
 - Year 4 (period=2): 30 *400 /(1.1 *20 *10^6) =0.545 kg
 - o ...
 - Year 10 (period=2): 30 *400 /(1.1 *20 *10^6) =0.545 kg
 - Year 11 (period=3): 30 *300 /(1.1 *20 *10^6) =0.409 kg
 - 0
- For "leachate" output, N is:
 - o Year 1 (period=1, P'=1): 30 *450 /(1.1 *20 *10^3) *2000E-6 =1.227E-3 kg

- o Year 2 (period=1, P'=1): 30 *450 /(1.1 *20 *10^3) *2000E-6 =1.227E-3 kg
- Year 3 (period=1, P'=1): 30 *450 /(1.1 *20 *10^3) *2000E-6 =1.227E-3 kg
- o Year 4 (period=2, P'=1): 30 *400 /(1.1 *20 *10^3) *2000E-6 =1.091E-3 kg
- o Year 5 (period=2, P'=1): 30 *400 /(1.1 *20 *10^3) *2000E-6 =1.091E-3 kg
- o Year 6 (period=2, P'=2): 30 *400 /(1.1 *20 *10^3) *4000E-6 =2.182E-3 kg
- ο.
- o Year 10 (period=2, P'=2): 30 *400 /(1.1 *20 *10^3) *4000E-6 =2.182E-3 kg
- o Year 11 (period=3, P'=2): 30 *300 /(1.1 *20 *10^3) *4000E-6 =1.636E-3 kg

ο..

Vegetable food waste 043

693

Office paper

0.01154

0.01545

- Year 16 (period=3, P'=3): 30 *300 /(1.1 *20 *10^3) *0 =0 kg
- For "Residues" output, all properties are the same as the input except from N and P, lets' check for N:
 - Vegetable food waste: 0.09175 sum_for_all_years[leachate.year.water *concentrate(N, P')*10^-6] *0.09175/0.09996)
 - = 0.09175 [3*1.227E-3 +2*1.091E-3 +5*2.182E-3 +5*1.636E-3] *0.09175/0.09996 =0.0688 kg
 - Office paper: 0.008217 sum_for_all_years[leachate.year.water *concentrate(N, P')*10^-6] *0.008217/0.09996)

= 0.008217 - [3*1.227E-3 +2*1.091E-3 +5*2.182E-3 +5*1.636E-3] *0.008217/0.09996 =0.006166 kg

Fraction name	and the second second second second second															
and the second se	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)
Sum	42.48	0	42.48	0	0	0	0	0	0	0	0	0	0	0	0.02496	0
Year 1	0.6137	0	0.6137	0	0	0	0	0	0	0	0	0	0	0	0.001227	0
Year 2	0.6137	0	0.6137	0	0	0	0	0	0	0	0	0	0	0	0.001227	0
Year 3	0.6137	0	0.6137	0	0	0	0	0	0	0	0	0	0	0	0.001227	0
Year 4	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.001091	0
Year 5	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.001091	0
Year 6	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.002182	0
Year 7	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.002182	0
Year 8	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.002182	0
Year 9	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.002182	0
/ear 10	0.5455	0	0.5455	0	0	0	0	0	0	0	0	0	0	0	0.002182	0
/ear 11	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0.001636	0
Year 12	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0.001636	0
Year 13	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0.001636	0
Year 14	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0.001636	0
Year 15	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0.001636	0
Year 16	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 17	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 18	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 19	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0	0
Year 20	0.4091	0	0.4091	0	0	0	0	0	0	0	0	0	0	0	0	0
	4			17						1						
mposition																▼ ↓ >
achate gene	eration - Residues															
isplay Def	ault]													
Fraction nam	e bio and (ko) C fo	ssil (kg)	Ca (kg)	Cl (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)	O (ko	a) P (kg)	S (kg)	На	(kg)
Contraction of the second s		-					1.37							1.31		

Figure S25: Composition of the two outputs of the "leachate generation" process

0.6385 0.005752 0.0008217 0.4109

0.02681 0.02705 0.000483 0.3188 0.06134 0.06886 0.01507 1.908 0.01111 0.008887 9.66E-08

0.0009696 0.006166 0.00636 3.016

0.0003124 0.005284 2.925E-07

1.16 Anaerobic digestion

This process has two outputs called "gas" and "digestate". The user needs to specify in the "Material transfer" window of the anaerobic digestion process:

- **Yields** (in %) for each material fraction. They describe how much of the "C bio and" is actually degraded in the digester. Like in the other tables, there is always a "default" fraction, and the user can add and delete lines (i.e. fractions).
- A factor called "Loss of VS related to loss of C bio" (named **vs_cbio** in the rest of the text). Default value: 1.89.
- A factor called "Part of CO2 going to the liquid phase (%)" (named **co2_liq** in the rest of this text). The default value is zero.
- A list of **pollutants** and their transfer coefficients (TC) from the input to the gas and digestate outputs, given by the user in **kg/Nm3 biogas**. The user selects the material property and writes a transfer coefficient in the column "Gas" for the default fraction line (and possibly to specific fractions), the value in the column "digestate" is automatically calculated as "100-TCgas". By default everything goes to digestate. NB: VS, Cbio, Cbioand and energy cannot be changed in this table because they are calculated based on the other parameters.

Calculation of CH4 for each material fractions (shown when clicking on button "View CH4%")

In the calculations of the outputs, we need to calculate for each material fraction a material property called **ch4_biogas**, which is in percentage the part of C bio that is transformed into CH4 (the rest being transformed into CO2). This is calculated based on 4 other material properties named "C bio and", "H", O" and "N" with this formula:

Ch4_biogas =
$$\frac{1}{2} + \frac{168 * H - 21 * O - 36 * N}{112 * Cbioand}$$
 (the value obtained is between 0 and 1)

> <u>Calculation of "Part of CO2 liquid" and "Measured CH4" depending on radio buttons</u>

- When the first radiobutton is selected: the user edits co2_liq and measuredCH4% is calculated

MeasuredCH4% is CH4 divided by biogas:

100* Sum_for_all_material_fractions_of (yield/100 * C_bio_and * ch4_biogas/100) /

[Sum_for_all_material_fractions_of (yield/100 * C_bio_and * ch4_biogas/100) + Sum_for_all_material_fractions_of (yield/100 * C_bio_and * (1-ch4_biogas/100)) *(1-co2_liq/100)]

- When the second radiobutton is selected: the user edits measuredCH4% and co2liq is calculated

Co2liq is calculated like this:

100 – (100-measured_ch4%) / measured_ch4% * Sum_for_all_material_fractions_of (yield/100 * C_bio_and * ch4_biogas/100) / Sum_for_all_material_fractions_of (yield/100 * C_bio_and * (1- ch4_biogas/100))

> <u>Calculation of the GAS output</u>

The gas output has one fraction called "Mix" with these properties:

C bio [kg] is: Sum_for_all_material_fractions_of (yield/100 * C_bio_and *(1-co2_liq/100*(1-ch4_biogas/100)))

- CH4 [m3] is: Sum_for_all_material_fractions_of (yield/100 * C_bio_and * ch4_biogas/100)*22.4/12
- CO2 [m3] is:
 Sum_for_all_material_fractions_of : (yield/100 * C_bio_and * (1-ch4_biogas/100)) *(1-co2_liq/100) *22.4/12
- Pollutants [kg]: Sum_for_all_material_fractions_of (pollutant_kg(fraction)*TC_of_pollutants_to_gas/100)
- All other properties are zero, including water, VS, ash, Energy, C bio and.

Calculation of the DIGESTATE output

The digestate output has the same number of material fractions as the input, and their names. It is defined as equal to the input minus what goes to the gas (I write "input." to designate properties of the input material). For each material fraction, here are the properties:

- C bio [kg] is: input.c_bio_input.C_bio_and *yield/100 *(1- co2_liq/100*(1-ch4_biogas/100)
- C bio and is: input.c_bio_and*(1 -yield/100)
- VS is: input.vs vs_cbio *C_bio_and *yield/100
- LHV dry [MJ] is: input.lhvdry /input.vs *(input.vs vs_cbio *C_bio_and *yield/100)
- For pollutants with defined transfer coefficients: pollutant [kg] = input.pollutant*TC_to_digestate/100
- All other properties are equal to the input, including water and ash.

> <u>Example:</u>

We use the example of 30 kg of 70 % vegetable food waste and 30 % office paper (Table S1). The theoretical CH4 ratios are: 54.45 % for vegetable food waste and 52.85 % for office paper.

a. With radio button on "Part of CO2..."

Material ge	neration Anserobic digestion				
Anaerobic digestion					100 % 🕞 न 🖓 न न न न न 🕀
Material transfer					▼ ậ :
Anaerobic digestion					
Anaerobic digestio	n				
Define gas yield as prop	ortion of degradable carbon	Parameters related to biogas generation		Define transfer of	oefficient to gas and digesta
+ Add fraction		- Theoretical ratios of CH4 in biogas View	CH4 %	For substance:	N •
Fraction name	Yields (% C bio and)	- Partitioning of CO2 between gas and liquid pha	ases calculated with:	Add fraction	
X Vegetable food waste	70	Part of CO ₂ going to the liquid phase (%)	10	Fraction name	Gas Digestate
K Default	10	Measured CH ₄ % in biogas	0		50 50
		Parameters related to mass balance			30 70
		Loss of VS related to loss of biogenic carbon	1.89		

Figure S26: Material transfer of the "anaerobic digestion" process

The value "Measured CH4% in biogas" is:

100* (70/100 * 2.043 * 54.45/100 + 10/100 * 1.693 * 52.85/100) / [(70/100 * 2.043 * 54.45/100 + 10/100 * 1.693 * 52.85/100) + (70/100 * 2.043 * (1-54.45/100) + 10/100 * 1.693 * (1-52.85/100)) * (1-10/100)] = 56.88

The gas output is:

- C bio [kg] = 70/100 * 2.043 * (1-10/100*(1-54.45/100)) + 10/100 * 1.693 * (1-10/100*(1-52.85/100)) =1.526 kg

- CH4 [m3]= $(70/100 \times 2.043 \times 54.45/100 + 10/100 \times 1.693 \times 52.85/100) \times 22.4/12 = 1.621 \text{ m}^3$
- CO2 [m3] =(70/100 * 2.043 * (1-54.45/100) + 10/100 * 1.693 * (1-52.85/100))*(1-10/100)*22.4/12 =1.228 m³
- N [kg]: 0.09177*30/100 + 0.008217*50/100 = 0.03164 kg

omposition										•	म :
naerobic diges	tion - Gas										
Display Gas		•]								
Fraction name	Energy (MJ)	C bio (kg)	C fossil (kg)	CH4 (m^3)	CO2 (m^3)	+ (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	F
Sum	0	1.526	0	1.621	1.228)	0	0.03164	0	0	0
Mix	0	1.526	0	1.621	1.228		0	0.03164	0	0	0

Figure S27: Composition of the gas output

The digestate output is:

- C bio (vfw)= 2.294 2.043 *70/100 *(1-10/100*(1-54.45/100))= 0.929 kg (ofp)= 3.065 - 1.693*10/100 *(1-10/100*(1-52.85/100)) =2.904 kg
- C bio and (vfw) = 2.043 *(1-70/100) = 0.613 kg (ofp)= 1.693*(1-10/100) = 1.524 kg
- VS (vfw) = 4.579 1.89*2.043 *70/100 = 1.876 kg (ofp) = 6.516 - 1.89*1.693*10/100 = 6.196 kg
- LHV dry (vfw) = 88.389/4.579*(4.579 1.89*2.043 *70/100) = 36.21 MJ (ofp) = 103/6.516*(6.516 - 1.89*1.693*10/100) = 97.94 MJ
- N (vfw) =0.09177* 70/100 =0.06424 kg (ofp) = 0.008217*50/100 = 0.004109 kg
- All other properties are equal to the input

mposition																		▼ ‡
naerobic digestion	Digestate																	
Display Default	•																	
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	P (kg)
Sum	26.98	10.02	16.96	8.072	1.952	134.1	3.833	2.136	0.02699	0.6653	0.0328	0.001305	0.7296	0.06231	0.06835	0.02143	4.923	0.01147
Vegetable food waste	18.29	2.127	16.17	1.876	0.2512	36.21	0.9292	0.6129	0.01154	0.02681	0.02705	0.000483	0.3188	0.06134	0.06424	0.01507	1.908	0.01116
Office paper	8.685	7.897	0.7875	6.196	1.701	97.9	2.904	1.523	0.01545	0.6385	0.005752	0.0008217	0.4109	0.0009696	0.004109	0.00636	3.016	0.0003139

Figure S28: Composition of the digestate output

b. <u>With radio button on "Part of CO2..." (only this changes)</u>

Material generation Anaerobic digest	on	
Anaerobic digestion		10
Material transfer Anaerobic digestion Anaerobic digestion		
Define gas yield as proportion of degradable carbon	Parameters related to biogas generation	Define transfer coefficient to gas and digestate
+ Add fraction	- Theoretical ratios of CH4 in biogas View CH4 %	For substance: N
Fraction name Yields (% C bio and) Vegetable food waste 70 Default 10	Partitioning of CO ₂ between gas and liquid phases calculated with: Part of CO ₂ going to the liquid phase (%) Measured CH ₄ % in biogas Parameters related to mass balance	Fraction Fraction name Gas Office paper 50 Default 30
	Loss of VS related to loss of biogenic carbon 1.89	

Figure S29: Material transfer of the "anaerobic digestion" process

The value "Part of CO2 going..." is:

100 - 100*(100-60)/60*(70/100*2.043*54.45/100 + 10/100*1.693*52.85/100) / (70/100*2.043*(1-54.45/100) + 10/100*1.693*(1-52.85/100)) = 20.84

All the other calculations are the same as before. The gas output is:

- C bio [kg] = 70/100 * 2.043 * (1-20.84/100*(1-54.45/100)) + 10/100 * 1.693 * (1-20.84/100*(1-52.85/100))=1.447 kg
- CH4 [m3] = (70/100 * 2.043 * 54.45/100 + 10/100 * 1.693 * 52.85/100) * 22.4/12 = 1.621 m³
- CO2 [m3] =(70/100 * 2.043 * (1-54.45/100) + 10/100 * 1.693 * (1-52.85/100))*(1-20.84/100)*22.4/12 = 1.0805 m³
- N [kg]: 0.09177*30/100 + 0.008217*50/100 = 0.03164 kg

Anaerob	ic diges	tion - Gas										
Display	Gas		-]								
Fraction	n name	Energy (MJ)	C bio (kg)	C fossil (kg)	CH4 (m^3)	CO2 (m^3)	+ (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	P
Sum		0	1.432	0	1.621	1.053)	0	0.03164	0	0	0
Mix		0	1.432	0	1.621	1.053		0	0.03164	0	0	0

Figure S30: Composition of the gas output

The digestate output is:

- C bio (vfw)= 2.294 2.043 *70/100 *(1-20.84/100*(1-54.45/100))= 0.9997 kg (ofp)= 3.065 - 1.693*10/100 *(1-20.84/100*(1-52.85/100)) =2.912 kg
- C bio and (vfw) = 2.043 *(1-70/100) = 0.613 kg (ofp)= 1.693*(1-10/100) = 1.524 kg
- VS (vfw) = 4.579 1.89*2.043 *70/100 = 1.876 kg (ofp) = 6.516 - 1.89*1.693*10/100 = 6.196 kg
- LHV dry (vfw) = 88.389/4.579*(4.579 1.89*2.043 *70/100) = 36.21 MJ (ofp) = 103/6.516*(6.516 - 1.89*1.693*10/100) = 97.94 MJ
- N (vfw) =0.09177* 70/100 =0.06424 kg (ofp) = 0.008217*50/100 = 0.004109 kg
- All other properties are equal to the input

omposition															
naerobic digestion -	Digestate														
Display Default	•														
Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	CI (kg)	F (kg)	H (kg)	K (kg)	N (kg)
Sum	26.98	10.02	16.96	8.072	1.952	134.1	3.927	2.136	0.02699	0.6653	0.0328	0.001305	0.7296	0.06231	0.0683
Vegetable food waste	18.29	2.127	16.17	1.876	0.2512	36.21	1.013	0.6129	0.01154	0.02681	0.02705	0.000483	0.3188	0.06134	0.06424
Office paper	8.685	7.897	0.7875	6.196	1.701	97.9	2.914	1,523	0.01545	0.6385	0.005752	0.0008217	0.4109	0.0009696	0.00410

Figure S31: Composition of the digestate output

Figure S32 provides explanations about the calculations happening in the anaerobic digestion process.

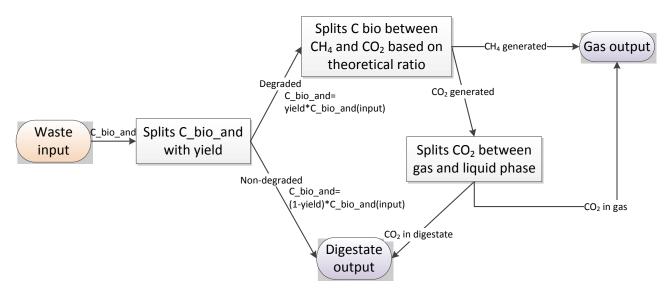


Figure S32: Calculations in the "Anaerobic digestion" process

1.17 Use-on-land

If the tickbox is ticked in "Material transfer", the process has one output defined as the exact opposite of the input, i.e. for each material property of the input of value x, the material property of the output has a value "-x". If the tickbox is not ticket, there is no output.

2 LCA calculations in all processes: process-specific emissions and external processes

Here we explain how the calculations are performed in material processes and external processes, concerning all data specified in the "Process exchanges" tab. Note that some material processes templates include also emissions happening in the "Material transfer" tab, these calculations are detailed in Section 3. The steps of characterization, normalization and weighting are always the same, and are thus only explained in Section 2.

The example which will be used in Section 2 is presented in Figure S33. Throughout the example we will use an impact category called "IPCC 2007, climate change, GWP 100a" which has characterisation factors of 1 for "carbon dioxide, fossil, air, unspecified" and 25 for "Methane, fossil, air, unspecified" (kg CO_2 -eq/kg).

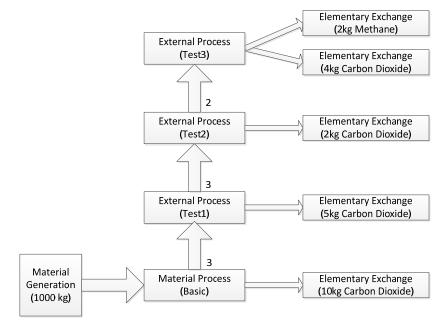


Figure S33: Example used in Section 2

2.1 An external process with only process-specific emissions: test3

The external process "test3" is presented in Figure S34. It has two process-specific emissions (we call all elementary exchanges in the "Process exchanges" tab of a process "process-specific" as they are related to the process being operated):

Pro	cess exchanges					
te	st3 (External Process)					
E	Add external processes Add external process Elementary exchan Add elementary exchange	ges				
	Name	Compartment	Sub compartment	Amount	Unit	Comment
-	Carbon dioxide, fossil	air	unspecified	4	kg	
~						

Figure S34: Process exchanges in external process test3

The LCI of an external process such as "test3" is presented in Figure S35 and calculated as:

- All elementary exchanges which are directly in the "Process exchange" tab of "test3" are called "Process-specific emissions" and are simply put directly in the LCI (see the 6th column below).
- For each external process used (in "test3" none), bring the LCI of the process (explained in Section 2.2 with "test2" process).
- The total column (5th column) shows simply the sum for all columns for the functional unit for the process.

CI						
test3 (External Process)						
life cycle inventory pe	r process					
Show per material fraction						
show per material material						
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions
	Compartment air	Sub compartment unspecified	Unit kg	Total 4	Input-specific emissions 0	Process-specific emission: 4

Figure S35: LCI of external process test3

In the characterized impacts, "per substance" view, the calculation is taking the LCI line by line: for each elementary exchange of the LCI, multiply the total amount by the characterization factor of the impact category. So for "test3" characterised impacts are presented in Figure S36 and calculated as:

- Carbon dioxide: amountOfCarbonDioxideInLCI*CharacterisationFactorOfCarbonDioxide = 4*1=4
- Methane, fossil: amountOfMethaneInLCI*CharacterisationFactorOfMethane = 2*25=50

test3 (External Pro	ocess)			
Life cycle in	p <mark>act assessm</mark>	ent: charac	terised impac	ts
LCIA Method:	theTestingMethod •		Show per pro	ocess view
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq
Sum				54
Carbon dioxide, fossil		air	unspecified	4
Methane, fossil		air	unspecified	50

Figure S36: Characterised impacts, per substance, of external process test3

In the characterized impacts, "per process" view, we take the LCI results column per column: for each subprocess, calculate the total impact as the sum (for all elementary exchanges) of their amount multiplied by the characterization factor.

In "test3", there is only one sub-process called "Process-specific emissions" and it is contributing to: amountOfCarbonDioxideInLci(Process specific emissions)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCI(Process specific emissions)*CharacterisationFactorOfMethane = 4*1+2*25=54

Results are shown in Figure S37. If "test3" was calling another external process, we would do the same calculation for this process (see the example in section 2.2).

Charact. imp.				
test3 (External Proc	ess)			
Life cycle im	pact a	ssessment: characte	rised impacts	
LCIA Method:	theTes	tingMethod •	Show per substance view	
Name		IPCC 2007, climate change, GW kg CO2-Eq	/P 100a	
Sum 54				
Process-specific er	nissions	54		
Input-specific emis	sions	0		

Figure S37: Characterised impacts, per process, of external process test3

2.2 An external process with process-specific emissions and one external process: test2

Figure S38 presents the external process "test2".

-			Process)							
Ξ) Ext	terna	l proc	esse	s					
	🖊 🖡	Add exte	rnal proces	s	1					
		Name	Amount	Unit	Commer	nt				
×	View	test3	2	kg						
			tary ex		nges					
1	Nam	e				Compartment	Sub compartment	Amount	Unit	Comment
-	Carl	on diavi	ide, fossil			air	unspecified	2	kg	

Figure S38: Process exchanges in external process test2

The LCI of "test2" has now two subprocesses: "Process specific emissions" and "test3". It is shown in Figure S39 and calculated as:

- All elementary exchanges which are directly in the "Process exchanges" tab of "test2" are called "Process-specific emissions" and are simply put directly in the LCI (see the 6th column below),
- For each external process used, you have to multiply the LCI of the process by the amount. In our example, "test2" uses 2 kg of test3 so in the column "test3" we have:
 - Carbon dioxide: amount(test3UsedInTest2)* amountOfCarbonDioxideInLci(test3)=2*4=8.
 - Methane: amount(test3UsedInTest2)* amountOfMethaneInLci(test3)=2*2=4.

LCI							
test2 (External Process)							
Life cycle inventory pe	er process						
Show per material fraction							
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test3
Carbon dioxide, fossil	air	unspecified	kg	10	0	2	8
Methane, fossil	air	unspecified	kg	4	0	0	4

Figure S39: LCI of external process test2

In the characterized impacts per substance (Figure S40) the calculation is the following:

- Carbon dioxide: amountOfCarbonDioxideInLCI*CharacterisationFactorOfCarbonDioxide =10*1=10.
- Methane: amountOfMethaneInLCI*CharacterisationFactorOfMethane =4*25=100.

1-12/5	1				
test2 (External Pro	ocess)				
Life cycle im	pact assessm	nent: charac	terised impac	ts	
LCIA Method:				ocess view	
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100 kg CO2-Eq	
Sum				110	
Carbon dioxide, fossil		air	unspecified	10	
Methane, fossil		air	unspecified	100	

Figure S40: Characterised impacts, per substance, of external process test2

In the characterized impacts per process (Figure S41) the details of each subprocess "test3" and "process-specific emission" are calculated:

- For the subprocess "test3":

amountOfCarbonDioxideInLCIPerProcess(Test3)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCIPerProcess(Test3)*CharacterisationFactorOfMethane = 8*1 + 4*25=108

- For Process-specific emissions:

amountOfCarbonDioxideInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfMethane = 2*1 + 0*25=2

haract. imp.	
test2 (External Process)	
Life cycle impact	assessment: characterised impacts
LCIA Method: theTe	stingMethod Show per substance view
Name	IPCC 2007, climate change, GWP 100a kg CO2-Eq
Sum	110
test3	108
Process-specific emissions	2
Input-specific emissions	0

Figure S41: Characterised impacts, per process, of external process test2

2.3 An external process with process-specific emissions and an external process that uses another external process: test1

Figure S42 presents "test1" an external process that uses "test2".

	exchang External	pes Process)						
		l proc		S				
+	Add exte	rnal proces	is .	1				
4	Name	Amount	Unit	Comment				
View	test2	3	kg					
-) Ele	emen	tary ex	kcha	nges				
🖊 Ac	ld elemer	ntary excha	nge					
Nar	ne			Compartmen	t Sub compartment	Amount	Unit	Comment
Carl	on diox	ide, fossil		air	unspecified	5	kg	

Figure S42: Process exchanges in external process test1

The LCI of "test1" is shown in Figure S43(again it has two sub-processes). The calculation is the same as in section 2.2:

- All elementary exchanges which are directly in the "Process exchanges" tab of "test1" are called "Process-specific emissions" and are simply put directly in the LCI (see the 6th column below),
- For each external process used, you have to multiply the LCI of the process by the amount. In our example, "test1" uses 3 kg of test2 so in the column "test2" we have:
 - Carbon dioxide: amount(test2UsedInTest1)* amountOfCarbonDioxideInLCI(test2)=3*10=30
 - Methane: amount(test2UsedInTest1)* amountOfMethaneInLCI(test2)=3*4=12

LCI							
test1 (External Process)							
Life cycle inventory pe	er process						
Show per material fraction							
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test2
Carbon dioxide, fossil	air	unspecified	kg	35	0	5	30
Methane, fossil	air	unspecified	kg	12	0	0	12

Figure S43: LCI of external process test1

In the characterized impacts per substance (Figure S44) the calculation is:

- Carbon dioxide: amountOfCarbonDioxideInLci*CharacterisationFactorOfCarbonDioxide =35*1=35
- Methane: amountOfMethaneInLci*CharacterisationFactorOfMethane =12*25=300

test1 (External Pro	ocess)			
Life cycle in	pact assessm	ent: charac	terised impac	ts
LCIA Method:	Method: theTestingMethod •			ocess view
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100 kg CO2-Eq
Sum				335
Carbon dioxide, fossil		air	unspecified	35
Methane, fossil		air	unspecified	300

Figure S44: Characterised impacts, per substance, of external process test1

In the characterized impacts per process (Figure S45) the details of each subprocess: "test2" and "process-specific emission" are calculated:

- Test2: amountOfCarbonDioxideInLCIiPerProcessOfTest2*CharacterisationFactorOfCarbonDioxide
 + amountOfMethaneInLCIPerProcessOfTest2*CharacterisationFactorOfMethane = 30*1 + 12*25=330
- Process specific emissions: amountOfCarbonDioxideInLCIPerProcessOfProcessSpecific*CharacterisationFactorOfCarbonDioxi de + amountOfMethaneInLCIPerProcessOfProcessSpecific*CharacterisationFactorOfMethane = 5*1 + 0*25=5

Charact. imp.								
test1 (External Process)								
Life cycle impact a	assessment: characterised impacts							
LCIA Method: theTes	stingMethod Show per substance view							
Name	IPCC 2007, climate change, GWP 100a kg CO2-Eq							
Sum	335							
test2	330							
Process-specific emissions	5							
Input-specific emissions	0							

Figure S45: Characterised impacts, per process, of external process test1

2.4 A material process uses this external process

The scenario presented in Figure S46 has 1000 kg waste (100% vegetable food waste) going to a basic process that uses -3 kg of test1 per MJ energy input and emits 10 kg of carbon dioxide.

Scenario 1]								
Material genera process-specifi Process exchang Basic Externa	es	J		Basic		7			
	rnal proces		1						
Name	Amount	Unit	Per	Co	omment				
View test1	-3	kg	MJ Energy	1					
Elemen			inges						
Name				Compartment	Sub compartment	Amount	Unit	Per	Comment
Carbon diox	de, fossil			air	unspecified	10	kg	kg Total Wet Weight	

Figure S46: Process exchanges in basic process

The LCI of material processes is similar to the one of external processes (Figure S47):

- All elementary exchanges which are in the "Process exchanges" tab of "Basic" are called "Processspecific emissions". Their amount in the LCI is: "Amount"_field * amount_of_the_selected_material_property_in_input_material

In our example, we emit 10 kg carbon dioxide per kg total wet weight (here equal to 1000) so we emit: 10*1000=1E4 kg.

- For each external process used, we get its LCI by:

LCI_of_the_external_process *"Amount"_field *amount_of_the_selected_material_property_in_input_material

In our example, we use -3 kg of test1 per MJ of Energy of the input (here equal to 4209 MJ), so we calculate in the 6^{th} column:

- Carbon dioxide: amountOfCarbonDioxideInLCI(test1) *amount(test1UsedInBasic)
 *Energy(input) = 35 *(-3) *4209 = -4.419E5
- Methane: amountOfMethaneInLCI(test1) *amount(test1UsedInBasic) * Energy(input) =12
 *(-3)*4209 = -1.515E5

LCI							
Basic							
Life cycle inventory pe	er process						
Show per material fraction							
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test1
Carbon dioxide, fossil	air	unspecified	kg	-4.319E+05	0	9999	-4.419E+05
Methane, fossil	air	unspecified	kg	-1.515E+05	0	0	-1.515E+05

Figure S47: LCI of basic process

In the characterized impacts per substance (Figure S48) the calculation is the following:

- Carbon dioxide: amountOfCarbonDioxideInLCI *CharacterisationFactorOfCarbonDioxide = -4.319E5*1 = -4.319E5
- Methane: amountOfMethaneInLci*CharacterisationFactorOfMethane = -1.515E5 *25 = -3.787E6

Basic						
Life cycle im	pact assessm	ent: charac	terised impac	ts		
LCIA Method:	theTestingMeth	od 🔹	Show per process view			
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq		
Sum				-4.22E+06		
Carbon dioxide, f	ossil	air	unspecified	-4.319E+05		
Methane, fossil		air	unspecified	-3.788E+06		

Figure S48: Characterised impacts, per substance, of basic process

In the characterized impacts per process (Figure S49) the details of each subprocess: "test1" and "process-specific emission" are calculated:

- <u>Test1</u>: amountOfCarbonDioxideInLCIPerProcess(Test1)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCIPerProcess(Test1)*CharacterisationFactorOfMethane = -4.419E5*1 + (-1.515E5)*25 = -4.229E6
- <u>Process specific emissions</u>: amountOfCarbonDioxideInLciPerProcess(ProcessSpecific)*CharacterisationFactorOfCarbonDioxid

e + amountOfMethaneInLciPerProcess(ProcessSpecific)*CharacterisationFactorOfMethane = 9999*1 + 0*25=1E4

Basic					
Life cycle in	pact a	ssessment: c	haracte	rised i	mpacts
LCIA Method:	theTes	tingMethod	•	Show	per substance view
Name		IPCC 2007, climate kg CO2-Eq	change, GV	VP 100a	
Sum		-4.22E+06			
test1		-4.23E+06			
Process-specific emissions		9999			
Input-specific em	issions	0			

Figure S49: Characterised impacts, per process, of basic process

2.5 Normalised and weighted impacts

The tabs "Norm. imp" and "Weight. Imp." are very similar to "Charact. Imp." with the same "per substance" and "per process" views. Figure S50 presents the normalization and weighting factors used.

Scenario 1 LCIA Method	ls		
LCIA Method: theTestin	gMethod 🔹	Edit	Create new
Unit for normalised impacts:	PE		
Unit for weighted impacts:	PET		
Add new impact categ	ory 🔒 두		
Impact category	Normalisation factor	Weighting	g factor
🗱 IPCC 2007, climate change,	2	10	

Figure S50: Normalisation and weighting factors used

The normalized impacts are obtained by <u>dividing</u> each number in the <u>characterized</u> impacts by the normalization factor of the impact category.

In the example of the scenario, we calculate based on characterized impact values (Figure S51):

- Carbon dioxide: we had -4.32E5 kg so the normalised impact for the category "IPCC 2007, climate change, GWP 100 a" is: -4.32E5/2 = -2.16E5 PE
- Methane: we had 3.79E6 kg so normalised impact for the category "IPCC 2007, climate change, GWP 100 a" is: -3.79E6 /2 = -1.9E6 PE

lorm. imp.				
Basic				
Life cycle in	pact assessm	ent: norma	lised impacts	
LCIA Method: theTestingMethod		Show per pro	ocess view	
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a PE
Sum				-2.11E+06
Carbon dioxide, f	ossil	air	unspecified	-2.16E+05
Methane, fossil		air	unspecified	-1.894E+06

Figure S51: Normalised impacts, per substance, of basic process

And we also divide the characterised impacts in the "per process" view (Figure S52).

Basic			
Life cycle im	pact a	assessment: normalis	sed impacts
LCIA Method:	theTes	stingMethod 🔹	Show per substance view
Name		IPCC 2007, climate change, GV PE	VP 100a
Sum		-2.11E+06	
test1		-2.115E+06	
Process-specific emissions		4999.5	
Input-specific em	issions	0	

Figure S52: Normalised impacts, per process, of basic process

And the weighted impacts are obtained by <u>multiplying</u> each number in the <u>normalised</u> impacts by the weighting factor of the impact category.

In the example of the scenario, in the normalised imp. per substance view, we had for:

- Carbon dioxide: -2.16E5 kg so the weighted impact for the category "IPCC 2007, climate change, GWP 100 a" is: -2.16E5 *10 = -2.16E6 PE
- Methane: -1.9E6 kg so normalised impact for the category "IPCC 2007, climate change, GWP 100 a" is: -1.9E6 *10 = -1.9E7 PE

Figure S53 and S54 show the weighted impacts, per substance and per process, respectively.

Basic				
Life cycle in	pact assessm	ent: weigh	ted impacts	
LCIA Method:	theTestingMeth	od 🔹	Show per pro	ocess view
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a PET
Sum				-2.11E+07
Carbon dioxide, f	ossil	air	unspecified	-2.16E+06
Methane, fossil		air	unspecified	-1.894E+07

Figure S53: Weighted impacts, per substance, of basic process

Veight. imp.				
Basic				
Life cycle im	npact a	ssessment: weigl	hteo	d impacts
LCIA Method:	theTes	stingMethod	•	Show per substance view
Name		IPCC 2007, climate change PET	e, GW	/P 100a
Sum		-2.11E+07		
test1		-2.115E+07		
Process-specific e	emissions	5E+04		
Input-specific em	issions	0		

Figure S54: Weighted impacts, per process, of basic process

2.6 Particular case: Material generation

In the material generation process, the user can attach the use of an external process to each material fraction by ticking the tick box "Include upstream impacts" (See Figure S55).

Material generation Material generation	ation:	amount and f	fractions		
Total amount (kg) 30					
Include upstream im Add fraction		ise composition to 10	0%		
Material fraction	%	Upstream impacts	Amount pr kg fraction	Unit	
X Vegetable food was	te 70	test3	2	kg	View

Figure S55: Process exchanges in material generation process

The LCI calculation is for each external process:

LCI = Total_amount *Percentage_field/100 *AmountPerKgFraction *LCI(external_process)

In the example, let's calculate for test3:

- Carbon dioxide: 30 *70/100 *2 *4 = 168 kg
- Methane: 30 * 70/100 * 2 * 2 = 84 kg

And for test1:

- Carbon dioxide: 30 *30/100 *3 *35 = = 945 kg
- Methane: 30 * 30/100 * 3 * 12 = 324 kg

er process						
Compartment	Sub compartment	Unit	Total	Input-specific emissions	test3	test1
air	unspecified	kg	1 <mark>1</mark> 13	0	168	945.1
air	unspecified	kg	408	0	84.01	324
	Compartment	Compartment Sub compartment air unspecified	Compartment Sub compartment Unit air unspecified kg	Compartment Sub compartment Unit Total air unspecified kg 1113	Compartment Sub compartment Unit Total Input-specific emissions air unspecified kg 1113 0	Compartment Sub compartment Unit Total Input-specific emissions test3 air unspecified kg 1113 0 168

Figure S56: LCI of material generation process

Characterised impact per substance works at process level and at scenario level are calculated as usual by multiplying the total amounts by the characterization factors (Figure S57).

Material generat	tion						
Life cycle im	pact assessm	nent: charac	terised impac	ts			
LCIA Method:	theTestingMethod		Show per process view				
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq			
Sum				1.131E+04			
Carbon dioxide, f	ossil	air	unspecified	1113			
Methane, fossil		air	unspecified	1.02E+04			

Figure S57: Characterised impact, per substance, of material generation process

Characterised impact per process is calculated by calculating the impact for each external process:

sum_for_each_ele_exch [Total_amount *Percentage_field/100 *AmountPerKgFraction
*LCI(external_process) *characterization_factor(elem. exch)]

In our example, we use an impact category with the characterization factor of 1 for "carbon dioxide" and 25 for "methane", so:

- o test3: 30 *70/100 *2 *4 *1 + 30 *70/100 *2 *2 *25 = 168*1 + 84*25 = 2268
- o test1: 30 *30/100 *3 *35 *1 + 30 *30/100 *3 *12 *25 = 945*1 + 324*25 = 9045

So the characterized impacts are as shown in Figure S58 at process level.

Charact. imp.	Material generation ife cycle impact assessment: characterised impacts				
Material generation					
Material generation Life cycle impact assessment: characterised impacts LCIA Method: theTestingMethod Show per substance view Name IPCC 2007, climate change, GWP 100a kg CO2-Eq Sum 1.131E+04 Image: Color C					
LCIA Method: th	eTes	tingMethod 🔹	Sł	how p	per substance view
Name			0a		
Sum		1.131E+04			
test3		2268			
test1		9046			
Process-specific emiss	sions				
Input-specific emissio	ns				

Figure S58: Characterised impact, per process, of material generation process

2.7 Particular case: Energy generation

This process is similar to material generation process except that we need to back-calculate the "Total amount" of input.

En	ergy	generation: a	mou	nt and fractio	ons							
Tot	al amoi	unt (MJ) 30										
	✓ Include upstream impacts ✓ Add fraction Normalise composition to 100% ✓ Mass Material fraction % Upstream impacts Amount pr kg fraction Unit ※ ✓ Vegetable food waste 70 test3 2 kg View											
	Mass	e upstream impacts Id fraction Norma Material fraction Vegetable food waste	%	Upstream impacts	Amount pr kg fraction	Unit						
×	1	Vegetable food waste	70	test3	2	kg	View					
×		Office paper	30		0		View					

Figure S59: Process exchanges in energy generation process

The LCI calculation is for each external process:

Total_amount(MJ) *Percentage_field(fraction)/100 /energy%(fraction, MJ/kg) *100/TS%(fraction) *AmountPerKgFraction *LCI(external process)

where energy% and TS% are the properties of the material fraction as found in the library of material fractions.

For vegetable food waste test3 emits: 30 *70/100 /18.3 *100/23 *2 *[4 kg CO2; 2 kg CH4] = [39.91 kg CO2; 19.95 kg CH4]

LCI						
Energy generation						
Life cycle inventory	per process					
Show per material fraction	j					
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	test3
Carbon dioxide, fossil	air	unspecified	kg	39.91	0	39.91
	air	unspecified	kq	19.96	0	19.90

Figure S60: LCI of energy generation process

The characterised impacts per substance are for CO2: 39.91 and for CH4: 19.96*25=499.

Energy generativ				
Energy generation				
Life cycle im	pact assessn	nent: charac	terised impac	ts
LCIA Method: theTestingMe		nod 🔹	Show per pro	ocess view
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq
Sum				538.8
Carbon dioxide, f	ossil	air	unspecified	39.91
Methane, fossil		air	unspecified	498.9

Figure S61: Characterised impact, per substance, of energy generation process

Charact. imp.					
Charact. imp. Energy generation Life cycle impact assessment: characterised impacts LCIA Method: theTestingMethod Characterised impacts Characterised impacts Characterised impacts Characterised impacts Characterised impacts Characterised impacts LCIA Method: theTestingMethod					
Life cycle im	pact a	ssessment: charad	te	rised i	impacts
LCIA Method:	theTes	tingMethod •		Show	per substance view
Name			GW	P 100a	
Sum		538.8			
test3		538.8			
Process-specific e	missions				
Input-specific emi	ssions				

Figure S62: Characterised impact, per process, of energy generation process

3 Input-specific emissions in four material processes

In this section, we explain how the LCI calculations are performed in the material processes templates that include emissions happening in the "Material transfer" tab. These emissions are called "input-specific". Remember that all processes can have "process-specific" emissions due to data in the "Process exchanges" tab (explained in Section I). The 4 processes that can have "input-specific" emissions are:

- Substance transfer per fraction.
- Substance transfer default.
- Use on land.
- Emissions to the environment.

Figure S32 shows the example used where we connect a material generation process each time to a different material process.

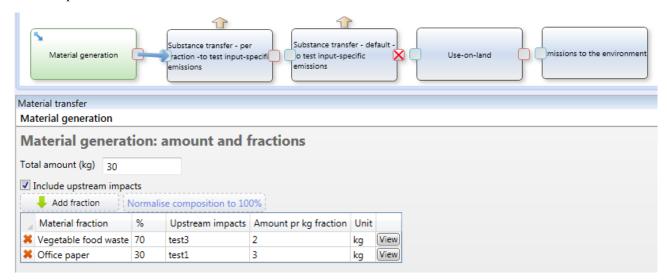


Figure S63: Scenario used to show the calculations of input-specific emissions

This is the composition calculated out of the material generation process.

Fraction name	Total Wet Weight (kg)	TS (kg)	Water (kg)	VS (kg)	Ash (kg)	Energy (MJ)	C bio (kg)	C bio and (kg)	C fossil (kg)	Ca (kg)	Cl (kg)	F (kg)
Vegetable food waste	21	4.83	16.17	4.579	0.2512	88.389	2.294	2.043	0.01154	0.02681	0.02705	0.000483
Office paper	9.005	8.217	0.7875	6.516	1.701	103	3.065	1.693	0.01545	0.6385	0.005752	0.0008217

Fraction name	H (kg)	K (kg)	N (kg)	Na (kg)	O (kg)	P (kg)	S (kg)	Ag (kg)	Al (kg)	As (kg)
Vegetable food waste	0.3188	0.06134	0.09177	0.01507	1.908	0.01116	0.008887	0	0.004975	1.265E-06
Office paper	0.4109	0.0009696	0.008217	0.00636	3.016	0.0003139	0.005284	0	0.01076	1.75E-06

3.1 Substance transfer per fraction

Figure S64 shows the added emissions to the "air unspecified" compartment:

- For Cfossil, 2% goes to the air except for the fraction "Vegetable food waste" for which it goes at 15%. Al goes at 40% to the air.
- And we have some process-specific emissions of aluminium and methane, and the use of test3.

laterial transfer				
Substance transfer - p	er fraction - Copy			
Substance tran	sfer - per fractio	on		
Define transfer coe	-		Show only de	fined transfers
	🔶 Add fraction)	→ →
Fraction name	air - unspecified (%)	Residues (%) 🥥	Add output	Add Add
X Vegetable food was	te 15	85	column	compartment degradation
洋 Default	2	98		
ubstance transfer - p Substance tran Define transfer coe	sfer - per fractio	on 	Show only de	fined transfers
	Add traction		_	
	air - unspecified (%	Residues (%) 🧳	1.1	Add Add compartment degradation
Fraction name			column	

Figure S64: Material transfer for the "substance transfer per fraction" process

Pro	cess (exchang	es									
Su	bstai	nce trai	nsfer - pe	er frac	tion -to t	est input-sp	oeci	ific emissions				
Ξ	Ext	terna	l proc	esse	s							
	+ /	Add exte	rnal proces	s)							
	Name Amount Unit Per				Per	Comment						
×	K View test3 0.003 kg kg Total		kg Total V	Vet Weight								
Ξ	Ele	emen	tarv ex	ccha	naes							
	Name		Compartment		Sub compartment	Amount	Unit	Per	С			
×	Aluminium		air		unspecified	0.002	kg	kg Total Wet Weight				
×	Methane, fossil				air unspecifie		unspecified	0.05	kg	kg Total Wet Weight		

Figure S65: Process exchanges for the "substance transfer per fraction" process

Note that we need an "interface" to explain to EASETECH how Cfossil is emitted: it is emitted as carbon dioxide with a conversion factor of 44/12 (this interface is here by default, just check if you have the right numbers) (see Figure S66).

					9	earch	
Compartment	Sub-compartment					Elementary excha	anges
🕜 air	indoor					0	
🕜 air	low population density, long-term					26	
🖌 air	lower stratosphere + upper troposphere					26	
🖌 air	non-urban air or from high stacks					26	
🖌 air	unspecified					26	
🕜 air 🔽 direct human unta	urban air close to ground					26	
Sub-compartme	nt unspecified	T					
Compartment	Sub compartment	Name	Amount	Unit	Per		
🗶 air	unspecified	Carbon dioxide, non-fossil	44 / 12	kg	kg C bio		
🗶 air	unspecified	Carbon dioxide, fossil	44 / 12	kg	kg C fossil		
💥 air	unspecified	Silver	1	kg	kg Ag		
🗶 air	unspecified	Aluminium	1	kg	kg Al		
•••••					line Ale		

Figure 66: Interface "air – unspecified"

So the LCI of these Material transfer emissions is calculated for each material property in the dropdown list as: SumForAllFractionsOf[TransferCoefficientToCompartment(fraction) *AmountProperty(fraction)] * ConversionFactorInInterface

So in our example:

LCI

- Carbon dioxide, air, unspecified: [0.15*input.cfossil(vegetablefoodwaste) +
- 0.02*input.cfossil(officepaper)] 44/12 = [0.15*0.01154 + 0.02*0.01545] + 44/12 = 0.00748 kg
- Aluminium, air, unspecified: [0.4*input.al(vegetablefoodwaste) + 0.4*input.al (officepaper)] *1
 = [0.4*0.004975 + 0.4*0.01076]*1 = 0.006294 kg

And of course the contributions of the "Process exchanges" tab:

- Process-specific:
 - Aluminium, air, unspecified: 0.002*30=0.06
 - Methane fossil, air, unspecified: 0.05*30=1.5
- Test3: $0.003*30*{2kg CH4; 4 kg CO2} = {0.18 kg CH4; 0.36 kg CO2}.$

Substance transfer - per fraction -to test input-specific emissions

Life cycle inventory per process

Show per material fraction								
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test3	1
Aluminium	air	unspecified	kg	0 <mark>.</mark> 0663	0.006296	0.06	0	1
Methane, fossil	air	unspecified	kg	1.68	0	1.5	0.18	
Carbon dioxide, fossil	air	unspecified	kg	0.3675	0.007482	0	0.36	
Carbon dioxide, non-fossil	air	unspecified	kg	0	0	0	0	
Silver	air	unspecified	kg	0	0	0	0	
Arsenic	air	unspecified	kg	0	0	0	0	
Barium	air	unspecified	kg	0	0	0	0	L
Beryllium	air	unspecified	kg	0	0	0	0	

Figure S67: LCI of the "substance transfer per fraction" process

	12.11	n -to test input-spe		4	
Life cycle in	ipact assess	sment: charac	terised impac	ts	
LCIA Method:	theTestingM	ethod 🔹	Show per pro	ocess view	
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq	
Sum				42.37	
Aluminium		air	unspecified	0	
Methane, fossil		air	unspecified	42	
Carbon dioxide, f	ossil	air	unspecified	0.3675	
Carbon dioxide, r	non-fossil	air	unspecified	0	
Silver		air	unspecified	0	
Arcenic		air	unspecified	0	

Figure S68: Characterised impacts (subs) of the "substance transfer per fraction" process

haract. imp.						
Substance transf	er - per	fraction -to test input-s	pecific	emissions		
Life cycle im	pact a	ssessment: char	actei	rised impa	cts	
LCIA Method:	theTes	tingMethod	•	Show per substance vie		
Name		IPCC 2007, climate change, GWP kg CO2-Eq		P 100a		
Sum		42.37				
test3		4.86				
Process-specific emissions		37.503				
Input-specific emissions		0.007482				

Figure S69: Characterised impacts (process) of the "substance transfer per fraction" process

3.2 Substance transfer default

We implement the same values as in "substance transfer per fraction" into a new process based on template "substance transfer default". The only difference is that in this process the user cannot specify different transfer coefficients for different material fractions.

	erial transfer				
Sul	ostance transfer - de	efault -to test input-s	pecific emissions		
Su	bstance trans	fer - default			
De	fine transfer coef	ficient (applied to a	all material fractio	ns)	
	•	Add material property		-	•
	Material property	erial property air - unspecified (% Degradation (Add output	Add
×	C fossil 2 98		98	column	compartment
×	AI	40	60		

Figure S70: Material transfer for the "substance transfer default" process

Proce	ess e	exchang	es								
Sub	Substance transfer - default -to test input-specific emissions										
Θ	Ext	terna	l proc	esse	s						
	₽ ¢	dd exte	rnal proces	s]						
4		Name	Amount	Unit	Per		Comment				
×v	View test3 0.003 kg kg Total Wet Weight										
$\overline{\bigcirc}$	Ele	men	tary ex	ccha	nges						
ŧ	Add	d elemen	ntary excha	nge	9						
N	Name Compartment Sub compartment Amo						Amount	Unit	Per	Comment	
X A	🗱 Aluminium air unspecified 0.002						0.002	kg	kg Total Wet Weight		
×N	1eth	ane, fos	ssil			air	unspecified	0.05	kg	kg Total Wet Weight	

Figure S71: Process exchanges for the "substance transfer default" process

The calculation of characterised impacts also relies on the interfaces.

Very similarly to "substance transfer per fraction", the LCI of these input-specific emissions is calculated for each material property in the dropdown list as: TransferCoefficientToCompartment * SumForAllFractionsOf (AmountProperty) * ConversionFactorInInterface

So in our example:

 Carbon dioxide, air, unspecified: 0.02*(input.cfossil(vegetablefoodwaste) + input.cfossil(officepaper)] *44/12 = 0.02* (0.01154 +0.01545]*44/12 =0.001979 kg - Aluminium, air, unspecified: 0.4* (input.al(vegetablefoodwaste) + input.al (officepaper)] *1 = 0.4*[0.004975 +0.01076]*1 =0.006294 kg

And the contributions of the "process exchange" tab:

- Process-specific:

-

- o Aluminium, air, unspecified: 0.002*30=0.06
- Methane fossil, air, unspecified: 0.05*30=1.5
- Test3: $0.003*30*{2kg CH4; 4 kg CO2} = {0.18 kg CH4; 0.36 kg CO2}.$

ife cycle inventory po	er process							
Show per material fraction								
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test3	
<mark>Aluminiu</mark> m	air	unspecified	kg	0.0663	0.006296	0.06	0	
Methane, fossil	air	unspecified	kg	1.68	0	1.5	0.18	1
Carbon dioxide, fossil	air	unspecified	kg	0.362	0.001979	0	0.36	1
Carbon dioxide, non-fossil	air	unspecified	kg	0	0	0	0	1
Silver	air	unspecified	kg	0	0	0	0	1
Arsenic	air	unspecified	kg	0	0	0	0	1
Barium	air	unspecified	kg	0	0	0	0	l
2 m	1	11.002					020	-1



Substance trans	fer - default -to t	est input-specific	emissions					
ife cycle in	pact assess	ment: charac	terised impac	ts				
LCIA Method:	theTestingMe	thod •	Show per pro	ocess view				
Name		Compartment		Compartment Sub compartme		IPCC 2007, climate change, GWP 100 kg CO2-Eq		
Sum				42.37				
Aluminium		air	unspecified	0				
Methane, fossil		air	unspecified	42				
Carbon dioxide, f	ossil	air	unspecified	0.362				
Carbon dioxide, r	non- <mark>foss</mark> il	air	unspecified	0				
		1						

Figure S73: Characterised impacts (subs) of the "substance transfer default" process

Substance transfer - default -to test input-specific emissions									
ife cycle im	pact a	ssessment: cha	ractei	rised in	pacts				
LCIA Method:	theTes	tingMethod	•	Show per substance view					
Name		IPCC 2007, climate char kg CO2-Eq	ige, GW	P 100a					
Sum		42.37							
test3		4.86							
Process-specific emissions		37.503							
Input-specific emissions		0.001979							

Figure S74: Characterised impacts (process) of the "substance transfer default" process

3.3 Use on land (UOL)

The material transfer tab of the UOL process contains all data to calculate the "input-specific" emissions. "Input-specific emissions" is the sub-process of all emissions coming from data in the Material transfer tab. As explained in Section I, "process-specific emissions" are elementary exchanges in the "Process exchanges" tab and each external process used is a subprocess as well.

Material tra	ansfer							
Use-on-la	and							
Use-or	n-land							
Define d	istributi	ons of bi	ogenic	carbon, nitr	ogen	and phospl	norous	
🔽 Include					-			
include	Substitut	cu now						
Distribu	tion of (Carbon (9	6)					
CO ₂ (air)) CH4 (air) C (soil st	orage)					
80	12	8						
Distribut	tion of I	litrogen	(%)					
N ₂ (air)	N ₂ O (air)	NH₃ (air)	NO₃ (lea	ching to GW)	NO₃ (runoff to SW)	N (plant uptake)	N (soil storage)
73	2	3	4		5		6	7
Distribut	tion of F	hosphor	ous (%)					
P (soil st	torage) P	O₃ (leachin	g to GW)	PO₃ (runoff t	to SW)	P (plant upta	ke)	

Figure S75: Material transfer for the UOL process

	exchang n-land	jes						
- E	terna	l proc	esse	s				
+	Add exte	rnal proces	is					
	Name Amount Unit Per Comment				Comment			
X View	test3	2	kg	kg Total Wet Weight				
		tary excha		inges				
Name				Compartm	Compartment Sub compartment		Unit	Per
🗙 Aluminium				soil	agricultural	0.8	kg	kg Al

Figure S76: Process exchanges for the UOL process

If I call a, b, c, d...n the values input in the 3 tables in the material transfer tab of UOL, the following inputspecific emissions have to be included in the LCI:

- "Carbon dioxide, <u>non-fossil</u>, air, unspecified": input.cbio * a/100 *(2*M_O+M_C)/M_C
- "Methane, non-fossil, air, unspecified": input.cbio * b/100 *(4*M_H+M_C)/M_C
- "Carbon dioxide, <u>fossil</u>, air, unspecified" = input.cbio * c/ 100 *($2*M_O+M_C$)/M_C * (-1)
- "Dinitrogen monoxide, air, unspecified": input.n * e/100 *(2*M_N+M_O)/(2*M_N)
- "Ammonia, air, unspecified": input.n * f/100 *(3*M_H+M_N)/M_N
- "Nitrates, water, ground-": input.n * g/100 *(3*M_O+M_N)/M_N
- "Nitrates, water, surface water": input.n * h/100 *(3*M_O+M_N)/M_N
- "Phosphate, water, ground-": input.p * 1/100 *(3*M O+M P)/M P
- "Phosphate, water, surface water": input.p * m/100 *(3*M_O+M_P)/M_P

Note that M_C, M_O, M_P and M_H are constants of the catalogue of constants and they are the molar masses of carbon, oxygen, phosphorous and hydrogen.

So the LCI of the subprocess "Input-specific" is calculated in the example like this:

- "Carbon dioxide, non-fossil, air, unspecified": (2.294+3.065) * 80/100 *(2*15.999+12.011)/12.011
 =15.71 kg
- "Methane, non-fossil, air, unspecified": (2.294+3.065)* 12/100 *(4*1.008+12.011)/ 12.011 =0.859 kg
- "Carbon dioxide, fossil, air, unspecified" = (2.294+3.065)* 8/ 100 *(2*15.999+12.011)/ 12.011* (-1)
 =-1.57 kg
- "Dinitrogen monoxide, air, unspecified": (0.09177+0.008217) * 2/100 *(2*14.007+15.999) /(2*14.007) =0.00314 kg
- "Ammonia, air, unspecified": (0.09177+0.008217) * 3/100 *(3*1.008+14.007)/ 14.007 =0.00364 kg
- "Nitrates, water, ground-": (0.09177+0.008217) * 4/100 *(3*15.999+14.007)/14.007 = 0.0177 kg
- "Nitrates, water, surface water": (0.09177+0.008217) * 5/100 *(3*15.999+14.007)/ 14.007 =0.0221 kg
- "Phosphate, water, ground-": (0.01116+0.0003139) * 8/100 *(3*15.999+30.974)/ 30.974 =0.00234 kg
- "Phosphate, water, surface water": (0.01116+0.0003139) * 9/100 *(3*15.999+30.974)/ 30.974
 =0.00263 kg

The process "test3" has also emissions as explained in part I: $2*30*{4kg CO2; 2kgCH4} = {240 kg CO2; 120 kg CH4}$.

And in "Process-specific emissions", we have one emission of aluminium of 0.8 kg/kg Al = 0.8*(0.004975+0.01076) = 0.01259 kg.

LCI							
Use-on-land							
ife cycle inventory p	er process						
Show per material fraction							
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test
Carbon dioxide, non-fossil	air	unspecified	kg	15.71	15.71	0	0
Carbon dioxide, fossil	air	unspecified	kg	238.4	-1.571	0	240
Methane, non-fossil	air	unspecified	kg	0.859	0.859	0	0
Dinitrogen monoxide	air	unspecified	kg	0.003142	0.003142	0	0
Ammonia	air	unspecified	kg	0.003647	0.003647	0	0
Nitrate	water	ground-	kg	0.0177	0.0177	0	0
Nitrate	water	surface water	kg	0.02213	0.02213	0	0
Phosphate	water	ground-	kg	0.00234	0.00234	0	0
Phosphate	water	surface water	kg	0.002632	0.002632	0	0
Aluminium	soil	agricultural	kg	0.01259	0	0.01259	0
Methane, fossil	air	unspecified	kg	120	0	0	120

Figure S77: LCI of the UOL process

For characterised impacts per substance, let's look only at the impact category "Climate change" that has characterisation factors for "carbon dioxide, fossil, air" of 1, for "Methane, air" of 25, for "dinitrogen monoxide" of 293:

- Carbon dioxide, fossil:
 - amountOfCarbonDioxideFossilInLCI*CharacterisationFactorOfCarbonDioxide=238.4*1=238.4*1
- Methane, fossil: amountOfMethaneFossilInLCI*CharacterisationFactorOfMethane =120*25=3000
- Methane, non-fossil: amountOfMethaneNonFossilInLCI*CharacterisationFactorOfMethane =0.859*25=21.47 kg
- Dinitrogen monoxide:

amountOfDinitrogenMonoxideInLCI*CharacterisationFactorOfDinitrogenMonoxide =0.003142*298=0.9363 kg

Use-on-land				
Life cycle in	pact asses	ssment: charac	terised impac	cts
CIA Method: theTesting		Nethod 🔹	Show per pro	ocess view
Name Sum		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq
				3261
Carbon dioxide, non-fossil		air	unspecified	0
Carbon dioxide,	fossil	air	unspecified	238.4
Methane, non-fo	ssil	air	unspecified	21.47
Dinitrogen mono	xide	air	unspecified	0.9363
Ammonia		air	unspecified	0
Nitrate		water	ground-	0
Nitrate		water	surface water	0
Phosphate		water	ground-	0
Phosphate		water	surface water	0
Aluminium		soil	agricultural	0
Methane, fossil		air	unspecified	3000.24

Figure S78: Characterised impacts (subs) of the UOL process

In the characterized impacts per process the details of each subprocess: "test3", "process-specific emission" are calculated:

- For the subprocess "test3":

amountOfCarbonDioxideInLCIPerProcess(Test3)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCIPerProcess(Test3)*CharacterisationFactorOfMethane = 240*1 + 120*25 = 3240 kg

 For Process-specific emissions: amountOfCarbonDioxideFossilInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfCar bonDioxide + amountOfMethaneInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfMethane + amountOfDinitrogenMonoxideInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfDini

trogenMonoxide

= -1.571*1 + 0.859*25 +0.003142*298 =20.84 kg

Use-on-land			
	pact a	ssessment: characte	rised impacts
LCIA Method:	theTes	tingMethod •	Show per substance view
Name		IPCC 2007, climate change, GV kg CO2-Eq	VP 100a
Sum		3261	
test3		3240	
Process-specific emissions		0	
Input-specific em	issions	20.84	

Figure S79: Characterised impacts (process) of the UOL process

3.4 Emissions to the environment

This process has also a material transfer tab that creates input-specific emissions. In the example following we see that 2 emissions are coming from the "Material transfer" tab (input-specific emission), while one is coming from the "Process exchanges" tab (process-specific emission) and we use one external process. So we have 3 sub-processes.

	erial transfer issions to the envir	onment					
		e environment the environment as tr ation	ransformation of s	ubstances			
	Material property	Transformed at (%) into	Elementary exchange	Compartment	Sub compartment	With the conversion factor	Com
×	kg Al	25	Aluminium	soil	agricultural	1	
	kg C bio	80	Carbon dioxide, fossil		unspecified	-44/12	

Figure S80: Material transfer for the Emissions to the environment process

Pro	cess	exchang	jes							
En	nissio	ons to t	he enviro	nmei	nt					
Ξ	Ex	terna	l proc	esse	s					
		Add exte	rnal proces	ss	1					
		Name	Amount	Unit	Per	Comment				
ĸ	View	test3	2	kg	kg Total Wet Weight					
-	Ele	men	tary ex	kcha	nges					
			ntary excha							
	Nam	ne -			Compartme	ent Sub compartment	Amount	Unit	Per	Comment
×	Alun	ninium			soil	agricultural	0.02	kg	kg Total Wet Weight	

Figure S81: Process exchanges for the Emissions to the environment process

The LCI of the emissions happening in the material transfer is calculated for each line as amountOfPropertyInInput *TransformedAtPercent/100 *ConversionFactor

So for our two emissions, it gives:

- Carbon dioxide, fossil, air, unspecified : input.Cbio*80/100*(-44/12) = -15.72 kg
- Aluminium, soil, agricultural: input.Al*25/100*1=0.003935 kg

For the other emissions, it happens as explained in part I: we have an (additional) emission of aluminium of 0.02*30=0.6 kg and emissions from test3 of $2*30*{2kg CH4; 4 kg CO2} = {120 kg CH4; 240 kg CO2}$.

D							
Emissions to the environment	t i						
ife cycle inventory p	er process						
Show per material fraction]						
Name	Compartment	Sub compartment	Unit	Total	Input-specific emissions	Process-specific emissions	test
Aluminium	soil	agricultural	kg	0.604	0.003935	0.6	0
Carbon dioxide, fossil	air	unspecified	kg	224.3	-15.72	0	240
Methane, fossil	air	unspecified	kg	120	0	0	120

Figure S82: LCI of the Emissions to the environment process

The "characterised impact per substance" tab shows as usual for each elementary exchange, the total amount multiplied by the characterisation factor.

Emissions to the	environment			
Life cycle im	pact assessn	nent: charac	terised impac	ts
LCIA Method:	theTestingMeth	nod 🔻	Show per pro	ocess view
Name		Compartment	Sub compartment	IPCC 2007, climate change, GWP 100a kg CO2-Eq
Sum				3225
Aluminium		soil	agricultural	0
Carbon dioxide, f	ossil	air	unspecified	224.3
Methane, fossil		air	unspecified	3000.24

Figure S83: Characterised impacts (subs) of the Emissions to the environment process

And the characterised impact per process shows for each subprocess, the sum for all elementary exchanges of amount multiplied by characterisation factor:

- For the subprocess "test3":

amountOfCarbonDioxideInLCIPerProcess(Test3)*CharacterisationFactorOfCarbonDioxide + amountOfMethaneInLCIPerProcess(Test3)*CharacterisationFactorOfMethane = 240*1 + 120*25 = 3240 kg

 For input-specific emissions: amountOfCarbonDioxideFossilInLCIPerProcess(ProcessSpecific)*CharacterisationFactorOfCar bonDioxide = -15.72*1 = -15.72 kg

haract. imp.					
Emissions to the	environ	nent			
ife cycle im	pact a	ssessment: charad	cte	rised i	impacts
LCIA Method:	theTes	tingMethod •	•	Show	per substance view
Name		IPCC 2007, climate change, kg CO2-Eq	GW	P 100a	
Sum		3225			
test3		3240			
Process-specific er	missions	0			
Input-specific emi	ssions	-15.72			

Figure S84: Characterised impacts (process) of the Emissions to the environment process

PART IV: CASE STUDY

In this document are presented screenshots of how the systems were implemented in EASETECH. Please refer to the original paper by Clavreul et al. (2012) for further details.

1 Scenario construction and data input

The name of the template used to build each module is provided, as well as screenshots showing the data. Note that parameters were used in some number fields, there value is given in the Section 3 of this Part III.

1.1 Incineration scenario

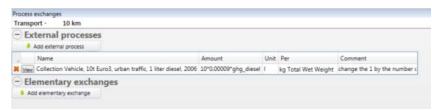
Material generation, based on "Material generation" template:

	Transport - Decrease of energy content lincineration www.TP indue to water evaporation	andfil leachate
Aaterial transfer		
Material generation		
Total amount (kg) 1000		
Total amount (kg) 1000 Include upstream impacts Add fraction Normalise compos	tion to 100%.	
Include upstream impacts Add fraction Normalise compos Material fraction	%	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste	% 62.4	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste	% 62.4 19.6	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste	% 62.4 19.6 6.5	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper	% 62.4 19.6 6.5 0.4	
Add fraction Normalise compose Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard	% 62.4 19.6 6.5	
Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard	% 62.4 19.6 6.5 0.4	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers	% 624 19.6 65 0.4 0.3 1.1 7.1	
Add fraction Normalise compose Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excements and bedding (straw)	% 624 196 65 04 03 11 71 16	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood	% 624 19.6 65 0.4 0.3 1.1 7.1	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood	% 624 196 65 04 03 11 71 16	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Animal food waste Dirty cardboard Non-recyclable plastic	% 624 196 65 04 03 11 16 0.7	

Collection, based on the "Basic process" template:

Process	exchanges				
Collect	ion				
Ex	ternal processes				
	Add external process				
4	Name	Amount	Unit	Per	Comment
X View	Collection Vehicle, 10t Euro3, urban traffic, 1 liter diesel, 2006	0.00327*ghg_diesel	1	kg Total Wet Weight	
- Ele	ementary exchanges				
	d elementary exchange				

Transport, based on the "Basic process" template:



Decrease of energy content due to water evaporation, based on the "Change of energy content" template:



Incineration plant, based on the "Substance transfer, default" template (note that the template "Substance transfer, per fraction" could have been used instead offering the possibility of giving different values to different material fractions):

	fer - default									
Define transfer coef	ficient (applied to a	all material fraction	ns)							
		🐥 Add mater	al property				-			
Material property	Fly ashes (%) 🏼 🖉	air - unspecified (%					Add			
¥ Water ¥ VS	0	0	0	0	100 99.9	men co	mpartie	NETIN		
X Ash	12.6	0	0	0.1	87.4					
K Energy	0	0	0	0	100					
K C bio	0	100	0	0	0					
K C bio and	0	0	0	0	100					
🗙 C fossil	0	100	0	0	0					
X CI	32.13	0.1073	62.46	5.303	-0.0003					
×s	60.91	0.099	15	23.991	7.105E-15					
X As X Cd	58.92	0.0121	0.4554	40.61	0.0025					
X Ha	88.13 96.25	0.0064 0.7475	0.0311 0.0936	11.83 2.909	0.0025					
X Cr	16.77	0.0394	0.0454	83.15	-0.0048					
X Cu	7.35	0.00261	0.0157	92.63	0.00169					
X Fe	3.06	0	0.018	96.622	0.3					
X Mo	2.54	0	0.8517	96.61	-0.0017					
× Ni	12.56	0.0329	0.0873	87.32	-0.0002					
X Pb	51.29	0.00081	0.2384	48,47	0.00079					
X Sb X Sn	59.84 48.18	0.0119	0.0643	38.91	0.0041					
View DISTRICT He	eating, margin	ai average, (D	к), кvvn, 2012	2			nea	at_rec	/100/3.0"gng_neat"(-1)
=		aı average, (D in H2O, produ						at_rec, E-05	/100/3.0"gng_neat"(-1)
View sodium hy		in H2O, produ					2.4	-	/100/3.0"gng_neat"(-1)
_{View}) sodium hy _{View}) lime, hydr	/droxide, 50% ated, packed,	in H2O, produ	uction mix, at				2.4 0.0	E-05	/100/3.0"gng_neat"(-1)
view sodium hy view lime, hydr view limestone	ydroxide, 50% ated, packed, , milled, packe	in H2O, produ at plant, CH	uction mix, at				2.4 0.0	E-05 0034 0567	/100/3.0"gng_neat"(-1)
view sodium hy view lime, hydr view limestone view polyethyle	ydroxide, 50% ated, packed, , milled, packe ene, HDPE, gra	in H2O, produ at plant, CH ed, at plant, CH anulate, at plan	uction mix, at I nt, RER		t plant, RER		2.4 0.0 0.0 6E-	E-05 0034 0567	/ 100/3.0"gng_neat"(-1)
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo	ydroxide, 50% ated, packed, , milled, packe ene, HDPE, gra vric acid, from	in H2O, produ at plant, CH ed, at plant, CH anulate, at plan the reaction o	uction mix, at I nt, RER f hydrogen w	: plant, RER vith chlorine, a		h, 2006	2.4 0.0 0.0 6E- 5.6	E-05 0034 0567 07 E-06	/100/3.6*ghg_elec*(-	
View sodium hy View lime, hydr View limestone	ydroxide, 50% ated, packed, , milled, packe	in H2O, produ at plant, CH ed, at plant, CH	uction mix, at				2.4 0.0	E-05 0034 0567	/100/3.0°gng_neat"(
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal View Marginal	ydroxide, 50% ated, packed, , milled, packe ene, HDPE, gra vric acid, from Electricity Con Electricity Con	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl.	uction mix, at H nt, RER f hydrogen w Fuel Product	: plant, RER vith chlorine, a tion, Coal, Ene			2.4 0.0 0.0 6E- 5.6 elec	E-05 0034 0567 07 E-06 c_rec/	/100/3.6*ghg_elec*(-	
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal	ydroxide, 50% rated, packed, , milled, packe ene, HDPE, gra pric acid, from Electricity Con Electricity Con	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl.	uction mix, at H nt, RER f hydrogen w Fuel Product	: plant, RER vith chlorine, a tion, Coal, Ene	rgy Quality, DK, kWI		2.4 0.0 0.0 6E- 5.6 elec	E-05 0034 0567 07 E-06 c_rec/	/100/3.6*ghg_elec*(-	
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal View Marginal Elementa	ydroxide, 50% rated, packed, , milled, packe ene, HDPE, gra pric acid, from Electricity Con Electricity Con	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl. sumption incl.	uction mix, at I nt, RER f hydrogen w Fuel Product Fuel Product	: plant, RER vith chlorine, a tion, Coal, Ene	rgy Quality, DK, kWl rgy Quality, DK, kWl		2.41 0.00 6E- 5.61 elec	E-05 0034 0567 07 E-06 c_rec/	'100/3.6*ghg_elec*(- s/1000*ghg_elec	
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal View Marginal Elementa	ydroxide, 50% ated, packed, , milled, packe ene, HDPE, gra rric acid, from Electricity Con Electricity Con rry excha ry exchange	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl. sumption incl.	uction mix, at I nt, RER f hydrogen w Fuel Product Fuel Product mpartment	: plant, RER vith chlorine, a tion, Coal, Ene tion, Coal, Ene Sub compartn	rgy Quality, DK, kWl rgy Quality, DK, kWl	h, 2006 Amou	2.41 0.00 6E- 5.61 elec	E-05 0034 0567 07 E-06 c_rec/ c_con	'100/3.6*ghg_elec*(- s/1000*ghg_elec	1)
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal View Marginal Elementa Add elementar Name	ydroxide, 50% ated, packed, , milled, packe ene, HDPE, gra pric acid, from Electricity Con Electricity Con rry excha ry exchange	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl. sumption incl. nges Co air	Int, RER Int, RER If hydrogen w Fuel Product Fuel Product	: plant, RER vith chlorine, a tion, Coal, Ene tion, Coal, Ene Sub compartn non-urban air	rgy Quality, DK, kWl rgy Quality, DK, kWl nent	Amou 3.3E-0	2.41 0.00 6E- 5.61 elec elec	E-05 0034 0567 07 E-06 c_rec/ c_con	/100/3.6*ghg_elec*(- s/1000*ghg_elec Per	1) nt
View sodium hy View lime, hydr View limestone View polyethyle View hydrochlo View Marginal View Marginal Elementa Add elementar Name Carbon monox	ydroxide, 50% rated, packed, , milled, packed, , milled, packe ene, HDPE, gra rric acid, from Electricity Con Electricity Con Electricity Con ry exchange ide, fossil red as 2,3,7,8-	in H2O, produ at plant, CH ed, at plant, CH anulate, at plant the reaction o sumption incl. sumption incl. nges Co air	uction mix, at 1 nt, RER f hydrogen w Fuel Product Fuel Product	: plant, RER vith chlorine, a tion, Coal, Ene tion, Coal, Ene Sub compartn non-urban air non-urban air	rgy Quality, DK, kWl rgy Quality, DK, kWl nent or from high stacks	Amou 3.3E-0 1.8E-1	2.41 0.00 6E- 5.61 elec elec nt 5 4	E-05 0034 0567 07 E-06 c_rec/ C_con Unit kg	/100/3.6*ghg_elec*(- s/1000*ghg_elec Per kg Total Wet Weigł	1) nt nt

Transport 500 km (boat), based on the "Basic process" template:

KWN |MJ En

kg Tot

kg Tot

kg Tot

kg Tot

kg Tot kWh MJ En kWh kg Tot

kg

kg

kg

kg

kg

Comment

⊖ E	cternal processes				
	Add external process				
4	Name	Amount	Unit	Per	Comment
X Vie	Bulk carrier ocean; technology mix; 100.000-200.000 dwt, ELCD, 2005	0.00569*1.76e5*500*1e-3	kg*km	kg Total Wet Weight	0.00569*1.76e-5 kgkm /km/tc

Utilisation of fly ashes, based on the "Basic process" template:

Process exchanges								
Utilization of fly ashes								
- External processe	5							
Add external process								
Name					Amount	Unit	Per	Comment
K View limestone, milled, pack	ed, at plant, CH				-0.035	kg	kg Total Wet Weight	substituted due to alkalinity of the residues
New Production and Combo	ustion of Diesel Oil in Truck	EU2, 1998			0.0006	kg	kg Total Wet Weight	Used for mixing the residues and pumping them to quarry
Kien Marginal Electricity Co	nsumption incl. Fuel Produ	ction, Coal, Energy C	Quality, Di	, kWh	2006 0.013*ghg_elec	kWh	kg Total Wet Weight	Used for mixing the residues and pumping them to quarry
Name	Compartment	Sub compartment	Amount	Unit	Per	Con	ment	
Name	Compartment	Sub compartment	Amount	Unit	Per	Con	ment	
X Lead	water	surface water	3.1E-10	kg	kg Total Wet Weight	Wast	e water emissions from	quarry
K Mercury	water	surface water	6.1E-11	kg	kg Total Wet Weight	Wast	e water emissions from	i quarry
X Sulfate	water	surface water	0.00082	kg	kg Total Wet Weight	Wast	e water emissions from	i quarry
X Chloride	water	surface water	0.0092	kg	kg Total Wet Weight	Wast	e water emissions from	n quarry
🗙 Zinc, ian	water	surface water	1.4E-08	kg	kg Total Wet Weight	Wast	e water emissions from	quarry
	water	surface water	1.5E-09	kg	kg Total Wet Weight	Wast	e water emissions from	i quarry
K Nickel, ion					a second second second second	107	a constant of the local state of the second	
X Nickel, ion Thallium	water	surface water	4.1E-10	kg	kg Total Wet Weight	Wast	e water emissions from	n quarry

Waste water treatment plant, based on the "Substance transfer - default" template:

ubstance trans	fer - default							
efine transfer coef	ficient (applied to a	Il material fraction	ns)					
	Add material property		-	-				
Material property	water - surface wab	Degradation (%)	Add output	Add				
Ca	15	85	column	compartment				
CI	15	85						
ĸĸ	15	85						
K Na	15	85						
R P	15	85						
s s	15	85						
AI AI	15	85						
As	30	70						
Cd	15	85						
Cr Cr	70	30						
Cu	50	50						
K Fe	15	85						
K Hg	15	85						
K Mg	15	85						
Mn Nn	15	85						
Mo Mo	15	85						
K Ni	15	85						
Pb	15	85						
Sb	15	85						
Sn Sn	15	85						
K Zn	30	70						
			4 .					
Process exchanges WWTP								
- External pr	OCOESOE							
Add external p	rocess					_		
Name					Amount	Unit	Per	Comment
	ctricity Consumption	incl. Fuel Production	Coal Energy	Quality, DK, kWh, 2006	0.004	kWh	kg Total Wet Weight	
(and the grint cie	the second second second	the second store	, com, criergy			Arres	ng total met melght	

Transport – 50 km, based on the "Basic process" template:

E	ternal processes				
+	Add external process				
4	Name	Amount	Unit	Per	Comment
X Mar	Road, Long haul truck, Euro3, 25t, Generic, 2006	50*0.00003	1	kg Total Wet Weight	adjust km

Landfill leachate generation, based on the "Leachate generation" template:

 External processes 									
and the second state of th									
Add external process									
Name				nit Per		Comment			
K View Marginal Electricity Consumption incl	Fuel Production, Coal, Energy Quality,	DK, kWh, 2006	0.003*ghg_elec kV	Vh kg T	Total Wet Weight				
K View diesel, at regional storage, RER			0.001 kg	kg T	Total Wet Weight				
Elementary exchanges Add elementary exchange									
laterial transfer andfill leachate generation									
eachate generation									
Time period duration (years)			Define leach	ate con	centrate (in mg/l	3			
Time period duration Net infiltration (mm/yr)	Time horizon of the inventory (in years)	100	🐥 Add substa						
X 4 00	Height of layer (m)	20	Name	222.02	Time period 1	Time period 2	Time period 3	Time period 4	
K 5 98 200		20	Duration (y	rs)	20	20	30	30	Ad
	Bulk density (t/m ³)	1.6	🗶 Ca		400	150	80	70	p
			Ӿ Sn		0.003	0.0015	0.0007	0.0007	1
			🗶 Sb		0.03	0.03	0.03	0.03	
					ere a	0.00	0.03	0.02	
			X Mo		0.5	0.2	0.1	0.05	
			¥ Mo ¥ Fe						
			and the second sec		0.5	0.2	0.1	0.05	
			🗶 Fe		0.5 0.01	0.2 0.01	0.1 0.01	0.05	
			¥ Fe ¥ Mn		0.5 0.01 0.007	0.2 0.01 0.003	0.1 0.01 0.001	0.05 0.01 0.0009	
			¥ Fe ¥ Mn ¥ Zn		0.5 0.01 0.007 0.02	0.2 0.01 0.003 0.015	0.1 0.01 0.001 0.001	0.05 0.01 0.0009 0.01	
			¥ Fe ¥ Mn ¥ Zn ¥ Mg		0.5 0.01 0.007 0.02 0.9	0.2 0.01 0.003 0.015 0.4	0.1 0.01 0.001 0.01 0.2	0.05 0.01 0.0009 0.01 0.1	
			¥ Fe ¥ Mn ¥ Zn ¥ Mg ¥ As		0.5 0.01 0.007 0.02 0.9 0.015	0.2 0.01 0.003 0.015 0.4 0.008	0.1 0.01 0.001 0.01 0.2 0.003	0.05 0.01 0.0009 0.01 0.1 0.001	
			 Fe Mn Zn Mg As S 		0.5 0.01 0.007 0.02 0.015 300 500 0.0025	0.2 0.01 0.003 0.015 0.4 0.008 120	0.1 0.01 0.001 0.01 0.2 0.003 50	0.05 0.01 0.0009 0.01 0.1 0.001 20	
			K Fe K Mn K Zn K Mg K As K		0.5 0.01 0.007 0.02 0.9 0.015 300 500	0.2 0.01 0.003 0.015 0.4 0.008 120 200	0.1 0.01 0.001 0.01 0.2 0.003 50 80	0.05 0.01 0.0009 0.01 0.1 0.001 20 35	
			K Fe K Mn K Zn K Mg K As S K K K K		0.5 0.01 0.007 0.02 0.015 300 500 0.0025	0.2 0.01 0.003 0.015 0.4 0.005 1.20 200 0.004	0.1 0.01 0.001 0.01 0.2 0.003 50 80 0.004	0.05 0.01 0.0009 0.01 0.1 0.001 20 35 0.003	
			K Fe Mn Zn Mg As S K Cr X Cu		0.5 0.01 0.007 0.02 0.9 0.015 300 500 0.0025 1.5	0.2 0.01 0.003 0.015 0.4 0.008 120 200 0.004 0.5	0.1 0.01 0.001 0.01 0.2 0.003 50 80 0.004 0.2	0.05 0.01 0.009 0.01 0.1 0.001 20 35 0.003 0.1	
			 Fe Mn Zn Mg As S K Cr Cu Hg 		0.5 0.01 0.007 0.02 0.9 0.015 300 500 0.0025 1.5 0.0005	0.2 0.01 0.03 0.4 0.008 120 200 0.004 0.5 0.0002	0.1 0.01 0.001 0.2 0.003 50 80 0.004 0.2 6E-05	0.05 0.01 0.001 0.01 0.01 0.01 20 35 0.000 35 0.000 22 -05	
			 Fe Mn Zn Mg As S K Cr Cu Hg Cd 		0.5 0.01 0.02 0.9 0.015 300 0.0025 1.5 0.00025 0.0005 0.0005	0.2 0.01 0.003 0.015 0.4 0.008 120 200 0.004 0.5 0.0002 5E-05	0.1 0.01 0.01 0.2 0.003 50 80 0.004 0.2 6E-05 5E-05	0.05 0.01 0.001 0.01 0.1 0.01 20 35 0.003 0.1 2E-05 2.5E-05	
			% Fe % Mn % Zn % Mg % As % S % K % Cr % Cu % Hg % Cd % P		0.5 0.01 0.007 0.02 0.9 0.015 300 500 0.0025 1.5 0.0005 0.25	0.2 0.01 0.003 0.015 0.4 0.008 120 200 0.004 0.5 0.0002 5E-05 0.13	0.1 0.01 0.001 0.001 0.003 50 80 0.004 0.2 6E-05 5E-05 5E-05 5E-05 5C-05	0.05 0.01 0.0009 0.01 0.1 0.001 20 35 0.003 0.1 25-05 2.56-05 0.04	
			% Fe % Mn % Zn % Mg % As % S % K % Cu % Hg % Cd % P % Na		0.5 0.01 0.007 0.9 0.015 300 0.005 1.5 0.0005 0.0005 0.0005 0.0002 0.25 2000	0.2 0.01 0.015 0.4 0.008 120 200 0.004 0.5 0.5 0.0002 55-05 0.13 700	0.1 0.01 0.001 0.2 0.003 50 80 0.2 80 0.02 66-05 55-05 55-05 0.06 5300	0.05 0.01 0.0009 0.01 0.1 0.01 20 35 0.003 35 0.003 0.1 2E-05 2.5E-05 0.04 80	
			 Fe Mn Zn Mg As S K Cr Cu Hg Cd P Na Ni 		0.5 0.01 0.007 0.02 0.9 300 500 0.0025 1.5 0.0005 0.0005 0.0005 0.0005 0.0002 0.25 2000 0.04	0.2 0.01 0.003 0.015 0.4 200 0.008 120 200 0.004 0.5 0.004 0.5 0.0002 58-05 0.13 700 0.01	0.1 0.01 0.001 0.001 0.003 50 80 0.004 0.2 6E-05 5E-05 5E-05 0.06 3000 0.003	0.05 0.01 0.0009 0.01 0.01 20 35 0.003 0.1 2E-05 2.5E-05 0.04 80 0.001	

Stored ecotoxicity, based on the "Substance transfer – default" template:

	rial transfer						
	ed ecotoxicity						
Su	bstance trans	fer - default					
Def	ine transfer coef	ficient (applied to	all material fractio	ns)			
			ateriai property				1
						-	-
	Material property	soil - stored (%)	water - stored (%)	Degradation (%)	-	Add output column	Add compartmen
×		50	50	0	-	column	compartmen
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0	E		
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
*		50	50	0			
×		50	50	0			
	Mg	50	50	0			
×		50	50	0			
×		50	50	0	1		
×		50	50	0			
*		50	50	0			
*		50	50	0			
×		50	50	0			
×	Mo	50	50	0			
×	Ni	50	50	0			
×	Pb	50	50	0			
×	Sb	50	50	0			
×	Se	50	50	0			
	Sn	50	50	0			
×		50	50	0			
×		50	50	0			
×		50	50	0			
×	Zn	50	50	0			

Leachate collection, based on the "Mass transfer over years" template:

ead	hate	e collection			
Ma	SS	transfer over y	/ears		
IIm	e po	eriod duration (yea	ars)		
		Time period duratic	Collected %	Not collected % 🖉	
		10	97	3	-
×		25	90	10	Add output
X X		35	50		column

Waste water treatment plant, based on the "substance transfer – default" template:

ibstance trans	fer - default ficient (applied to a	all material fractio	ns)				
	Add material property		-				
Material property	water - surface wate	Degradation (%)	Add output	Add			
Ca	15	85	column	compartment			
CI	15	85					
K	15	85					
Na	15	85					
p	15	85					
S	15	85					
Al	15	85					
As	30	70					
Cd	15	85					
Cr	70	30					
Cu	50	50					
Fe	15	85					
Hg	15	85					
Mg	15	85					
Mn	15	85					
Mo	15	85					
Ni	15	85					
РЬ	15	85					
Sb	15	85					
Sn	15	85					
Zn	30	70					
cess exchanges			-				
WTP - leachate							
Add external proc							
	C 33			Amo	unt Unit	Der	Comment
	city Consumption incl.	Fuel Production, Coal,	Energy Quality, I			kg Total Wet Weight	Comment
Elementary e							1

 $Emissions \ to \ groundwater, \ based \ on \ the ``substance \ transfer - default'' \ template:$

Su	bstance trans	fer - default				
De	fine transfer coef	ficient (applied to a	II material fractio	ons)		
		🐥 Add material property	1		-	-
	Material property	water - ground- (%)	Degradation (%)		Add output	Add
×	Ca	100	0		column	compartmen
×	CI	100	0			
×	F	100	0			
×	н	100	0			
×	к	100	0			
×		100	0			
×	Na	100	0			
×	0	100	0			
×	P	100	0			
×	S	100	0			
×	Ag	100	0			
×	AI	100	0			
×	As	100	0			
×	В	100	0	1		
×	Ba	100	0			
×	Be	100	0			
×	Br	100	0			
×	Cd	100	0			
×	Co	100	0			
×	Cr	100	0			
×	Cu	100	0			
×	Fe	100	0			
	Hg	100	0			
×	Mg	100	0			
×	Mn	100	0			
	Mo	100	0			
×	Ni	100	0			

🗙 Zn	100	0	
X V	100	0	
🗶 Ti	100	0	
🕺 Sr	100	0	
X Sn	100	0	
Se Sn Sr Ti	100	0	
🗱 Sb	100	0	
🗙 РЬ	100	0	
🕺 Ni	100	0	
X Mo	100	0	
		-	

1.2 Anaerobic digestion (AD) scenario

Material generation, based on "Material generation" template:

Material Collection	Transpo 10 km	ort - Anaerobic digestion Addition of water 30 km Joint - Use-on-land
Material generation		
fotal amount (kg) 1000		
Include upstream impacts	ition to 1	.00%
Include upstream impacts	ition to 1 %	.00%
Add fraction Normalise compose Material fraction		.00%
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste	%	00%
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste	% 62.4	.00%
Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels	% 62.4 19.6	00%
Add fraction Normalise compos Add fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper	% 62.4 19.6 6.5	00%
Add fraction Normalise compos Add fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard	% 62.4 19.6 6.5 0.4	.00%
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic	% 62.4 19.6 6.5 0.4 0.3	.00%
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers	% 62.4 19.6 6.5 0.4 0.3 1.1 7.1	.00%
Include upstream impacts Add fraction Normalise compose Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw)	% 62.4 19.6 6.5 0.4 0.3 1.1 7.1	
Include upstream impacts Add fraction Normalise compos Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood	% 62.4 19.6 6.5 0.4 0.3 1.1 7.1 1.6	.00%
Include upstream impacts Add fraction Normalise compose Material fraction Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood Other combustibles	% 62.4 19.6 6.5 0.4 0.3 1.1 7.1 1.6 0.7	.00%

Collection, based on the "basic process" template:

- External processes				
Add external process				
Name	Amount	Unit	Per	Comment
View Collection Vehicle, 10t Euro3, urban traffic, 1 liter diesel, 2006	0.0072*ghg_coll*ghg_diesel	1	kg Total Wet Weight	

Transport, based on the "basic process" template:

- External processes				
Add external process				
Name	Amount	Unit	Per	Comment
View Collection Vehicle, 10t Euro3, urban traffic, 1 liter diesel, 2006	10*0.00009*aha diesel	1	kg Total Wet Weight	change the 1 by the number of

Anaerobic digestion, based on the "Anaerobic digestion" template:

Anaerobic digestion									
Anaerobic digestio Define gas yield as property Add fraction	n ortion of degradable carbon	Parameters related to - Theoretical ratios of C		w CH4 %	•	Define transfe For substance:	r coefficient to gi	as and diges	
Fraction name	Yields (% C bio and)	- Partitioning of CO2 be	tween gas and liquid p	hases ca	alculated with:	Add fractio	m		
¥ Wood	5	Part of CO+ going	to the liquid phase (%) [1	3.32	And a state of the			
X Animal excrements and be	eddi 70	Measured CH ₄ %		· 144		-	e Gas Digestate		
X Yard waste, flowers	70	Wiedsured Cha /e	in blogas	c	h4_biogas	🕺 Default	40 60		
X Dirty paper	5	Parameters related to	mass balance						
X Kitchen towels	5								
X Animal food waste	yield	Loss of VS related to los	is of biogenic carbon	1	.95				
X Vegetable food waste	yield								
H Default	0								
rocess exchanges									
naerobic digestion									
- External process	es								
Add external process									
Name			Amount	Uni	t Per	Comment			
View Marginal Electricity C	onsumption incl. Fuel Production, Coa	l, Energy Quality, DK, kWh, 2006	elec_ad/1000*ghg_e	ec kWi	kg Total Wet Weight				
View diesel, at regional sto	rage, RER		0.0009*ghg_diesel	kg	kg Total Wet Weight				
- Elementary exch	anges								
Add elementary exchange									

CHP gas engine, based on "Emissions to the environment" template:

Material transfer CHP gas engine						
		ransformation of subs	ances			
Material property	Transformed at (%) into	Elementary exchange	Compartment	Sub compartment	With the conversion factor	Comment
¥ m^3 CH4	unburnt_ch4	Methane, non-fossil	air	non-urban air or from high stacks	16/22.4	Unburnt methane
🗱 m^3 CH4	98	Carbon dioxide, non-fossil	air	non-urban air or from high stacks	44/22.4	Burnt methane
	100	Carbon dioxide, non-fossil	air	non-urban air or from high stacks	44/22.4	
🗱 m^3 CO2		Mercury	air	unspecified		

Process exchanges									• ü >
CHP gas engine									
- External processes									
Add external process									
Name			A	moun			Unit	Per	Comment
View Marginal Electricity Consump	tion incl. Fuel Produc	ction, Coal, Energy Quality, DK, kWh	, 2006 (1	-unbu	rnt_ch4/100)*elec	_rec_ad/100*(-1)*CH4_LHV/3.6*ghg_elec	kWh	m^3 CH4	Elec rec 39% with 2% le
View District Heating, marginal average, (DK), kWh, 2012					rnt_ch4/100)*heat	t_rec_ad/100*(-1)*CH4_LHV/3.6*ghg_heat	kWh	m^3 CH4	Heat rec 46% with 2% I
4									,
 Elementary exchange Add elementary exchange 									
Name			Amount			Comment			
Name Nitrogen oxides	Compartment air	non-urban air or from high stacks	0.00268	kg	m^3 CH4	Comment			
			0.00268	kg	m^3 CH4	Comment			
Name Nitrogen oxides	air	non-urban air or from high stacks	0.00268 2.45E-06	kg kg	m^3 CH4 m^3 CH4	Comment			
Name Nitrogen oxides Dinitrogen monoxide	air air	non-urban air or from high stacks non-urban air or from high stacks	0.00268 2.45E-06 9.5E-05	kg kg kg	m^3 CH4 m^3 CH4 m^3 CH4	Comment			

Addition of water, based on the "Water content" template:

Material transfer Addition of water		
Water content		
Define the new wate	er content	
+	Add fraction	
Fraction name	% of wet weight	T
X Default	100-wc_dig	

Transport of digestate, based on the "Basic process" template:

Trans	port - 30 km kternal processes				
	Add external process				
CAL.	Name	Amount	Unit	Per	Comment
1	Road, Long haul truck, Euro3, 25t, Generic, 2006	dist*0.00003*ghg_diesel	1	kg Total Wet Weight	adjust km

Use on land, based on the "Use on land" template:

Use-on-land											
Jse-on-lan	d										
efine distribu	tions of hi	anonia a	arban nitr		d abas	abarau	_				
		logenic c	arbon, nu	ogen al	iu pnos	phorou	5				
] Include substi	tuted flow										
istribution o	f Carbon (9	6)									
CO ₂ (air) CH ₄	(air) C (soil st	torage)									
87 0	13										
stribution o	f Nitrogen	(%)									
	-		ching to GW)	NO ₂ (ru	noff to SV	V) N (pl	ant u	ptake	N (soil storage)	1	
50.6 1.4	1	22		25		0			0		
istribution o											
P (soil storage)		ng to GW)			and a state of the	take)					
100	0		0	0							
External p Add external					Amour			Unit	Der		ommen
Add external Name	process		el Oil in Truck	EU2, 199	Amour 8 0.00057		esel	Unit		-	ommer
Add external Name Production	process and Combust	tion of Dies	el Oil in Truck	, EU2, 199			sel		Per kg Total Wet Weig kg P	-	ommer
Add external p Add external Name Production www Average P	process and Combust Fertilizer, Euro	tion of Dies pe, 1997	el Oil in Truck	, EU2, 199	8 0.00057			kg kg	kg Total Wet Weig	-	ommen
External p Add external Name View Production View Average P View Average N	and Combust Fertilizer, Euro Fertilizer, Euro	tion of Dies pe, 1997 ppe, 1997	el Oil in Truck	, EU2, 199	8 0.00057	"ghg_die		kg kg	kg Total Wet Weig kg P	-	omment
External p Add external Name View Production View Average P View Average K View Average K Elementar	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 ope, 1997 ipe, 1997	el Oil in Truck	, EU2, 199	8 0.00057 -1 nfert/10	"ghg_die		kg kg kg	kg Total Wet Weig kg P kg N	-	ommen
External p Add external Name Production Average P View Average N View Average K Elementary	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 ope, 1997 pe, 1997 nges	el Oil in Truck		8 0.00057 -1 nfert/10 -1	"ghg_die 00*(-1)*gl	hg_n	kg kg kg	kg Total Wet Weig kg P kg N kg K	-	
External p Add external Name Production View Average P View Average N View Average K Elementar Name	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 pe, 1997 nges			8 0.00057 -1 nfert/10 -1	"ghg_die 00*(-1)*gl	hg_n	kg kg kg	kg Total Wet Weig kg P kg N kg K	ht	
External p Add external Name View: Production View: Average P View: Average N View: Average K Elementary Name Mercury	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 pe, 1997 nges (s	Compartment	Sub com	8 0.00057 -1 nfert/10 -1	(*ghg_die)0*(-1)*gl	hg_n t Uni	kg kg kg it Per	kg Total Wet Weig kg P kg N kg K r Hg	ht	
External p Add external Name View Production View Average P View Average N View Average K Elementary Name Mercury Aluminium	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pp, 1997 pe, 1997 1985 (s s	Compartment	Sub com agricultu	8 0.00057 -1 nfert/10 -1 partment ral	*ghg_die 00*(-1)*gi Amount 1	hg_n t Uni kg	kg kg kg it Per	kg Total Wet Weig kg P kg N kg K Hg Al	ht	
External p Add external Name Name View Production View Average P View Average N View Average K Elementar Add elementary Name Mercury Aluminium Arsenic Cadmium	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 sges (s s s s s s s s s s	Compartment oil oil oil oil	Sub com agricultur agricultur agricultur agricultur	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral	*ghg_die 00*(-1)*gi Amount 1 1 1	t Uni kg kg kg	kg kg kg it Per kg i kg i	kg Total Wet Weig kg P kg N kg K Hg Al	ht	
External p Add external Name View Production View Average P View Average N View Average K Elementary Name Mercury Aluminium Arsenic Cadmium Chromium	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 sges (s s s s s s s s s s s s	Compartment oil oil oil oil oil	Sub com agricultur agricultur agricultur agricultur agricultur	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1	hg_n t Uni kg kg	kg kg kg kg it Per kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al As Cd Cr	ht	
External p Add external Name Production View Production View Average P View Average N View Average K Elementary Name Mercury Aluminium Arsenic Cadmium Chromium Copper	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 ope, 1997 1998 (5 5 5 5 5 5 5 5 5 5 5 5 5	Compartment oil oil oil oil oil oil	Sub com agricultur agricultur agricultur agricultur agricultur agricultur	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1	hg_n kg kg kg kg	kg kg kg kg kg kg kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al As Cd Cr Cu	ht	
External p Add external Name View Production View Average P View Average N View Average K Elementary Name Mercury Aluminum Arsenic Cadmium Copper Iron	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 ope, 1997 nges (s s s s s s s s s s s s s s s s s s	Compartment oil oil oil oil oil oil oil oil oil	Sub com agricultur agricultur agricultur agricultur agricultur agricultur agricultur	8 0.00057 -1 nfert/10 -1 -1 partment ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1 1	hg_n kg kg kg kg kg kg	kg kg kg kg kg kg kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al As Cd Cd Cu Fe	ht	
External p Add external Name Production Veen Average P Veen Average N Veen Average K Elementary Name Mercury Aluminium Arsenic Cadmium Chromium Copper Iron Molybdenum	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 spe, 1997 iges iges is s s s s s s s s s s s s s s s s s	Compartment oil oil oil oil oil oil oil oil oil oil	Sub com agricultu agricultu agricultu agricultu agricultu agricultu agricultu agricultu	8 0.00057 -1 nfert/10 -1 -1 partment ral ral ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1 1 1 1	t Uni kg kg kg kg kg kg kg	kg kg kg kg kg kg kg kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al Al Cd Cr Cu Fe Mo	ht	
External p Add external Name Production Average P View Average N View Average K Elementary Name Mercury Aluminium Arsenic Cadmium Chromium Copper Iron Molybdenum Nickel	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 spe, 1997 nges s s s s s s s s s s s s s s s s s s	Compartment oil oil oil oil oil oil oil oil oil oil	Sub com agricultu agricultu agricultu agricultu agricultu agricultu agricultu agricultu	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1 1 1 1 1 1	hg_n kg kg kg kg kg kg kg kg	kg kg kg kg kg kg kg kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al Al Cd Cc Cc Cc Cc Cu Fe Mo Ni	ht	
External p Add external Name Name View Production View Production View Average P View Average N View Average N View Average K Elementary Name Add elementary Name Add elementary Name Add elementary Name Add elementary Name Corporer Iron Molybdenum Nickel Lead	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 nges (s s s s s s s s s s s s s s s s s s	Compartment oil oil oil oil oil oil oil oil oil oil	Sub com agricultu agricultu agricultu agricultu agricultu agricultu agricultu agricultu agricultu	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1 1 1 1 1 1 1	hg_n kg kg kg kg kg kg kg kg kg	kg kg kg kg kg kg kg kg kg kg kg kg kg k	kg Total Wet Weig kg P kg N kg K Hg Al Al Cd Cd Cc Cc Cc Cc Fe Mo Ni Pb	ht	ment
Name View Production View Average P View Average K View Average K	and Combust Fertilizer, Euro Fertilizer, Euro Fertilizer, Euro ry exchan	tion of Dies pe, 1997 pe, 1997 tges ((5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	Compartment oil oil oil oil oil oil oil oil oil oil	Sub com agricultu agricultu agricultu agricultu agricultu agricultu agricultu agricultu	8 0.00057 -1 nfert/10 -1 partment ral ral ral ral ral ral ral ral	*ghg_die 00*(-1)*gl Amount 1 1 1 1 1 1 1 1 1 1 1 1	hg_n kg kg kg kg kg kg kg kg	kg kg kg kg kg kg kg kg kg kg kg	kg Total Wet Weig kg P kg N kg K Hg Al Cd Cd Cc Cc Cu Fe Mo Ni Pb Zn	ht	

2 LCIA methods used

Table S2: Environmental impact categories and normalization references of the ILCD recommendedmethods. References given are first to method, next to normalization references.

Impact category	Method	Unit	Normali- sation factor	Year and space of normalisation, reference, remark
Climate change	IPCC (Forster et al., 2007)	kg CO ₂ -Eq	7730	Laurent et al., 2011a
Ozone depletion	EDIP97 (WMO) (Wenzel et al., 1997)	kg CFC-11- Eq	2.05E-2	Laurent et al., 2011a
Human toxicity, cancer effects	USEtox (Rosenbaum et al., 2008)	CTUh	3.25E-5	Laurent et al., 2011b
Human toxicity, non- cancer effects	USEtox (Rosenbaum et al., 2008)	CTUh	8.14E-4	Laurent et al., 2011b
Particulate matter/ respiratory inorganics	Updated from Humbert (2009), from SI of Laurent et al. (2012)	kg PM _{2.5} -eq	4.71	From SI of Laurent et al. (2012)
Acidification	ReCiPe (Van Zelm et al., 2008)	kg SO ₂ -Eq	49.9	Sleeswijk et al., 2008
Eutrophication, terrestrial	CML (Guinée et al. 2002)	kg NOx-Eq	356	Huijbregts et al, 2003 and CML(2012) ³
Photochemical ozone formation	ReCiPe (Van Zelm et al., 2008)	kg NMVOC	52.9	Sleeswijk et al., 2008
Eutrophication, freshwater	ReCiPe (Van Zelm et al., 2008)	kg P-Eq	0.69	Sleeswijk et al., 2008
Ecotoxicity (freshwater)	USEtox (Rosenbaum et al., 2008)	CTUe	5060	Laurent et al., 2011b
Resource depletion, mineral and fossil	CML(Guinée et al., 2002)	kg antimony- Eq	0.95	Guinée et al., 2002 ¹

¹Calculated based on population in EU-15 1995 assumed to: 380 million, and the total value for 1995: 1.4E+11 kg PO43- eq. / yr

3 Uncertainty propagation

In this section we present briefly how uncertainty data is input in EASETECH, how systems are parameterized and how results are displayed.

3.1 The table of parameters

Parameters are added simply by specifying a name to the parameter, a default value and a list of values to be used when running calculations in "sensitivity analysis" mode.

				Search			
	Name	Det	fault Value	SA Values	Selected		
K (2) p	plastic	1.12	2	1.228, 1.46, 0.8386, 1.454, 1.236, 1.291, 0.7952	1		
X 🕜 v	vc	67.1	L	60.27, 74.15, 67.67, 64.16, 65.68, 67.5, 70.11, 7	1		
K 🕜 H	۱v	19.2	21	19.14, 19.63, 18.39, 17.97, 17.89, 19.37, 17.69,	1		
K 🕜 🤉	ghg_diesel	1		0.9393, 0.9641, 1.065, 0.9407, 1.041, 0.8652, 0	1		
K 🕜 g	ghg_elec	1		1.068, 1.018, 0.9324, 0.9882, 0.8954, 1.02, 0.94	1		
K 🕜 g	ghg_heat	1		1.046, 1.146, 0.9954, 0.9872, 1.032, 1.075, 0.73	1		
K 🕜 g	ghg_coll	1		1.067, 1.224, 0.8462, 1.22, 1.071, 1.107, 0.824€	1		
K 🕜 o	dist	30		7.074, 133.2, 33.83, 16.11, 22.2, 32.64, 56.71, 8	1		
K 🕜 o	:h4_pot	450		447.6, 435.3, 420.7, 454.9, 469.1, 448, 472.8, 4	1		
K 🕜 o	:h4_biogas	63		62.8, 64.26, 60.55, 59.29, 59.03, 63.49, 58.45, €	1		
K 🕜 e	elec_ad	48.9)	53.99, 47.03, 49.45, 47.94, 48.43, 48.35, 44.38,	1		
K 🕜 e	elec_rec_ad	39		40.59, 37.6, 37.13, 34.32, 41.39, 38.1, 37.97, 39	1		
K 🕜 F	neat_rec_ad	46		43.52, 45.37, 44.78, 49.3, 52.53, 46.86, 45, 50.1	1		
🕻 🕜 у	vield	70		73.35, 70.57, 65.78, 68.79, 62.35, 61.89, 66.52,	1		
K 🕜 u	unburnt_ch4	2		1.953, 1.846, 2.386, 2.076, 1.909, 1.802, 2.239,	1		
K 🕜 v	wc_dig	3		4.344, 3.418, 1.602, 2.721, 1.205, 3.452, 1.817			
K 🕜 o	seq	13		10.78, 11.38, 12.09, 12.56, 14.45, 16.83, 14.10			
K 🕜 r	nfert	40		43.11, 47.7, 39.67, 39.1, 42.18, 44.77, 30.06, 31	1		
K 🕜 🤉	ghg_n	1		0.9058, 0.9438, 1.105, 0.9079, 1.066, 0.7955, 0	1		
K 🕜 r	n2o_uol	1.4		1.737, 3.01, 1.159, 0.6215, 2.342, 1.669, 1.334,	1		
K 🕜 v	/eg_of_food	76.1	L	75.62, 73.15, 70.24, 77.08, 79.92, 75.7, 80.66, 8	1		
	Name		parameter	_1	<u>Save</u>		
	Default value		1				
	SA values		1, 3, 7				

To run the calculations in "sensitivity analysis" mode, at least one parameter has to be selected and then the user should click on the "Run Sensitivity analysis" button.

		Search	
Name	Default Value	SA Values	Selected
🗶 🕜 plastic	1.12	1.228, 1.46, 0.8386, 1.454, 1.236, 1.291, 0.7952	1
🗮 🕜 wc	67.1	60.27, 74.15, 67.67, 64.16, 65.68, 67.5, 70.11, 7	1
🗶 🕜 hv	19.21	19.14, 19.63, 18.39, 17.97, 17.89, 19.37, 17.69,	1
🗮 🕜 ghg_diesel	1	0.9393, 0.9641, 1.065, 0.9407, 1.041, 0.8652, 0	1
🗶 🕜 ghg_elec	1	1.068, 1.018, 0.9324, 0.9882, 0.8954, 1.02, 0.94	1
X 🕜 ghg_heat	1	1.046, 1.146, 0.9954, 0.9872, 1.032, 1.075, 0.75	1
🗶 🕜 ghg_coll	1	1.067, 1.224, 0.8462, 1.22, 1.071, 1.107, 0.824€	1
X 📝 dist	30	7.074, 133.2, 33.83, 16.11, 22.2, 32.64, 56.71, 8	1
X 🕜 ch4_pot	450	447.6, 435.3, 420.7, 454.9, 469.1, 448, 472.8, 4	1
X 🕜 ch4_biogas	63	62.8, 64.26, 60.55, 59.29, 59.03, 63.49, 58.45, €	1
🗶 📝 elec_ad	48.9	53.99, 47.03, 49.45, 47.94, 48.43, 48.35, 44.38,	1
🗶 📝 elec_rec_ad	39	40.59, 37.6, 37.13, 34.32, 41.39, 38.1, 37.97, 39	1
🗱 📝 heat_rec_ad	46	43.52, 45.37, 44.78, 49.3, 52.53, 46.86, 45, 50.1	1
🗱 📝 yield	70	73.35, 70.57, 65.78, 68.79, 62.35, 61.89, 66.52,	1
🗱 🕜 unburnt_ch4	2	1.953, 1.846, 2.386, 2.076, 1.909, 1.802, 2.239,	1
🗶 🕜 wc_dig	3	4.344, 3.418, 1.602, 2.721, 1.205, 3.452, 1.817,	1
🗰 🕜 cseq	13	10.78, 11.38, 12.09, 12.56, 14.45, 16.83, 14.16,	1
🗰 🕜 nfert	40	43.11, 47.7, 39.67, 39.1, 42.18, 44.77, 30.06, 31	1
🗰 🕜 ghg_n	1	0.9058, 0.9438, 1.105, 0.9079, 1.066, 0.7955, 0	1
¥ 🕜 n2o_uol	1.4	1.737, 3.01, 1.159, 0.6215, 2.342, 1.669, 1.334,	1
🗶 🕜 veg_of_food	76.1	75.62, 73.15, 70.24, 77.08, 79.92, 75.7, 80.66, 8	1
	🔶 Add	new parameter	
		Stop Sensitivity Analysis	elect All

3.2 Material generation

The following figure is a screenshot showing how the waste generation was parameterised using four parameters: the content of plastic in the waste ("plastic"), the water content of the whole waste ("wc"), the lower heating value ("hv") and the methane potential ("ch4_pot"). It can be observed that to parameterize material generation, we use a different process than the classical one (presented in section Part II, Section 1.3). This process allows free definition of amounts of different properties. The screenshot presents the formulas used for the water content in the 12 material fractions. The pop-up window on the right side shows the table of parameters where all parameters are defined, together with their default value and the list of numbers to be tested. Here each parameter has a list of 1000 values randomly sampled in the distributions defined earlier. This lists of random values were obtained using a small excel macro.

File View Catalogues			Contraction of the second second				
Material processes 👻 🎙 🗙	Scenario 1				Search		
Material generation			Name	D.C. HULL		C 1	
Source separation		CHP gas engine		Default Value	SA Values	Selected	
Collection	Material	Anaerobic	🗶 🕜 plastic	1.12	1.228, 1.46, 0.8386, 1.454, 1.236, 1.291,	141	
Transport	generation	Collection 10 km digestion	× 2 wc	67.1	60.27, 74.15, 67.67, 64.16, 65.68, 67.5,	2	
MRF		Addition of water	¥⊘ hv	19.21	19.14, 19.63, 18.39, 17.97, 17.89, 19.37,		
Mixed waste Landfills		30 6	🕷 🕜 ghg_diesel	1	0.9393, 0.9641, 1.065, 0.9407, 1.041, 0.		
Material recycling	Material generation - with		K ghg_elec	1	1.068, 1.018, 0.9324, 0.9882, 0.8954, 1./		
Thermal treatment	parameters		X ghg_heat	1	1.046, 1.146, 0.9954, 0.9872, 1.032, 1.0		
Landfill mineral waste			X ghg_coll	1	1.067, 1.224, 0.8462, 1.22, 1.071, 1.107,	1	
Ash treatment			X 🕜 dist	30	7.074, 133.2, 33.83, 16.11, 22.2, 32.64, !		
Biological treatment			K C ch4_pot	450	447.6, 435.3, 420.7, 454.9, 469.1, 448, 4		
Use-on-land	Material generation - with par	ameters	K C ch4_biogas	63	62.8, 64.26, 60.55, 59.29, 59.03, 63.49, 1		
Template	and the second se		🗶 🕜 elec_ad	48.9	53.99, 47.03, 49.45, 47.94, 48.43, 48.35,	1	
Recovered processes	Material transfer		K gelec_rec_ad	39	40.59, 37.6, 37.13, 34.32, 41.39, 38.1, 3		
1999 - C.	Material generation - wit	h parameters	K heat_rec_ad	46	43.52, 45.37, 44.78, 49.3, 52.53, 46.86, 4		
	Material generati	on: manual input	🗶 🕜 yield	70	73.35, 70.57, 65.78, 68.79, 62.35, 61.89,	1	
			🗶 🕜 unburnt_ch4	2	1.953, 1.846, 2.386, 2.076, 1.909, 1.802,		
	Fraction name	Water (kg)	🕷 🕜 wc_dig	3	4.344, 3.418, 1.602, 2.721, 1.205, 3.452,	1	
	X Vegetable food waste	0.820233*(1-plastic/100)/(1-0.011239)*veg_of_food/100*1000*wc/100*0.77/0.67096	📕 🕜 cseq	13	10.78, 11.38, 12.09, 12.56, 14.45, 16.83,	1	
	X Animal food waste	0.820233*(1-plastic/100)/(1-0.011239)*(1-veg_of_food/100)*1000*wc/100*0.571/0.67096		40	43.11, 47.7, 39.67, 39.1, 42.18, 44.77, 30	1	
	Kitchen towels	0.06516*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.469/0.67096	🗮 🕜 ghg_n	1	0.9058, 0.9438, 1.105, 0.9079, 1.066, 0.	2	
	X Dirty paper	0.00413*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.245/0.67096	X n2o_uol	1.4	1.737, 3.01, 1.159, 0.6215, 2.342, 1.669,	120	
	X Dirty cardboard	0.002139*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.131/0.67096	K 🖉 veg_of_food	76.1	75.62, 73.15, 70.24, 77.08, 79.92, 75.7, 1	1	
	X Non-recyclable plastic	plastic/100*1000*wc/100*0.071/0.67096		🐥 Add ne	w parameter		
	¥ Yard waste, flowers	0.070589*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.482/0.67096					
		0.016389*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.604/0.67096			Stop Sensitivity Analysis S	elect All	
	¥ Wood	0.007306*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.159/0.67096					
	K Other combustibles	0.001448*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.095/0.67096	0.001448*(1-plastic/100)/(1-0.011239)*(1-wc/100*0.095/0.670960)*(1-26.9/100)*1000				
	X Soil	0.000609*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.456/0.67096	the balance of the second s		156/0.670960)*(1-43.9/100)*1000		
	X Other non-combustible	0.000658*(1-plastic/100)/(1-0.011239)*1000*wc/100*0.366/0.67096	0.000658*(1-plastic/100)/(1-0.01	1239)"(1-wc/100"0.3	66/0.670960)*(1-97.7/100)*1000		
		<					
			on .				
Material p., Projects		exchanges Documentation LCI Charact.imp. Norm.imp. Weight.imp. Composi					

3.3 Material composition calculation

The output of this process can be computed and is presented in the next figure. It can be observed that each result field shows the 1000 values obtained as a result of the computation with 1000 values for each parameter. All table results can always be copied and pasted into Excel, which offers simple tools to convert a cell of 1000 values into 1000 cells that can be easily analysed.

ile View Catalogues		Developmen
laterial processes 🔻 🕂 🗙	Scenario 1	
Material generation Source separation Collection Transport MRF Mixed waste Landfills Material recycling Thermal treatment Landfill mimeral waste Ash treatment	Material generation Material generation - with parameters	CHP gas engine Transport - 10 km Anserobic digestion Addition of water - Addition of water - 30 km Use-on-land
Biological treatment Use-on-land Template	Composition	100 %
	Composition Material generation - with parameters	
	Display Default	•
	Fraction name	Total Wet Weight (kg)
	Fraction name	Total Wet Weight (kg) 999,9,
	Sum	999.9, 999
	Sum Vegetable food waste	999.9, 99
	Sum Vegetable food waste Animal food waste	999,9, 99
	Sum Vegetable food waste Animal food waste Kitchen towels	999,9, 999,9,9,999,9,9,999,9,999,9,9,99,9
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper	999.0 , 990.0 , 990.0 , 990.0 , 1
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard	999.0 , 990.0 , 99
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic	999.0 , 990.0 , 990.0 , 990.0 , 1
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers	599.0 , 597.0 , 520.4 , 52
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw)	999.9 , 999.3 , 999.3 , 999.9 , 199.19.19.1.
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood	999.0 , 1 , 1 , 6 , 1 , 5 , 1
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood Other combustibles	999.9 , 199.19.1
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood Other combustibles Soil	599.0 , 599.3 , 5 31.1, 6 36.5, 6 54.5, 5 12, 5 31, 6 4.5, 5 112, 2 4.5, 1 25.8, 1 29, 0 21.1, 2 25.8, 1 11, 1 408, 1 564, 1 524, 1 29, 1 215, 2 144, 1 12, 2 518, 1 12, 1 201, 5 215, 5 135, 5 143, 5 24, 5 22, 5 532, 6 4, 5 503, 6 553, 6 534, 5 534, 6 524, 6 524, 6 531, 6 438, 6 505, 6 543, 6 532, 6 524, 6 505, 5 54, 6 553, 5 524, 5 57, 6 532, 6 524, 6 531, 6 438, 6 503, 6 439, 5 503, 6 534, 6 537, 6 524, 6 523, 6 543, 6 524, 1 14, 1 13, 4 125, 4 115, 4 1124, 1 125, 1 155, 1 147, 2 144, 2 133, 2 147, 2 147, 2 142, 2 144, 2 143, 2 143, 2 143, 2 144, 2 142, 2 144, 2 147, 2 117, 2 135, 2 145, 2 142, 2 142, 2 14, 2 144, 2 142, 2 144, 2 143, 2 113, 2 1155, 2 1155, 2 1157, 2 144, 2 142, 2 14, 2 144, 2 142, 2 144, 2 143, 2 113, 2 1135, 2 1155, 2 1155, 2 1157, 2 144, 2 144, 2 143, 2 141, 2 1417, 2 142, 2 144, 2 144, 2 117, 2 1137, 2 1155, 2 1155, 2 1157, 2 1142, 2 1144, 2 1154, 2 1155, 2 1142, 2 1142, 2 144, 2 1142, 2 144, 2 1142, 2 1
	Sum Vegetable food waste Animal food waste Kitchen towels Dirty paper Dirty cardboard Non-recyclable plastic Yard waste, flowers Animal excrements and bedding (straw) Wood Other combustibles Soil	999.9 , 999.1 , 191111111111111

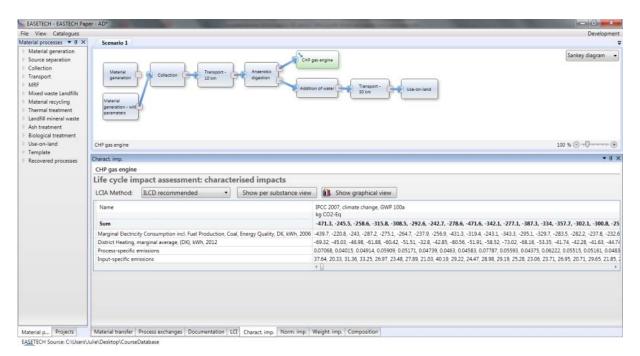
EASETECH Source: C:\Users\Julie\Desktop\CourseDatabase

3.4 LCI data in material process

In the same way, data of the other processes have been parameterized. Below is presented the example for the "CHP gas engine" material process.

File View Catalogues	Scenario 1							Development
Material generation Source separation Collection Transport MRF Mixed waste Landfills Material recycling Thermal treatment Landfill mineral waste Ach treatment	Material generation Material permettion - with parameters	Transport - 10 km	Anaerobic digestion	get engine	Transport - 30 km	Use-on-land		Sankey diagram 🔹
 Biological treatment Use-on-land 	CHP gas engine							100 % 🕞 - 🖓 •
 Template Recovered processes 	Process exchanges CHP gas engine External processes							• û X
	Add external process			L. Martin			Lassacia	Transferre
	Name			Amou			Unit Per	Comment
	K View District Heating, marginal av					c_rec_ad/100*(-1)*CH4_LHV/3.6*ghg_elec at_rec_ad/100*(-1)*CH4_LHV/3.6*ghg_hea		Elec rec 39% with 2% leakag Heat rec 46% with 2% leakag
							A Antonia	
	Elementary exchange Add elementary exchange	25						
	Name	Compartment	Sub compartment	Amount Un	t Per	Comment		
	🗶 Nitrogen oxides	air	non-urban air or from high stacks	0.00268 kg	m^3 CH4			
	🗶 Dinitrogen monaxide	air	non-urban air or from high stacks	2.45E-06 kg	m^3 CH4			
	🔀 Sulfur dioxide	air	non-urban air or from high stacks	9.5E-05 kg	m^3 CH4			
	🗱 Methane, non-fossil	air	non-urban air or from high stacks	0.0016 kg	m^3 CH4			
	🗱 Carbon monoxide, non-fossil	air	non-urban air or from high stacks	0.001354 kg	m^3 CH4			
			1. See 1.					

3.5 Calculation of the characterised impact



NB: the display of the results will be improved in the future, but it is still possible to make full use of the results by using excel tools.

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